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STUDIES IN GROWTH III*

BY FRANZ BOAS

I

THE problem treated in the present section relates to the influences of the date of birth upon growth.

The statures of all boys and girls measured in the Hebrew Orphan Asylum and of those in charge of the Hebrew Shelter and Guardian Society, admitted between 1905 and 1928, are given in Table 1.

It is well known that the average stature of Europeans has increased quite steadily from 1850 to 1914. I wished to investigate whether this phenomenon appears also among the growing children of immigrants. In order to avoid possible errors I investigated first (Table 2) the statures of the parents of immigrant children contained in my Report on Changes in Bodily Form of Immigrants.[1] These measurements were taken in 1910. The ages of the adults give, therefore, at the same time the year of birth.

* I am indebted to the coöperation of the staff of the Hebrew Orphan Asylum in New York, particularly to the Director, Mr. Lionel J. Simmonds, for their liberal assistance. Calculations were carried through by Miss Florence A. Meyer, Dr. Carolyn Adler, and Miss Bertha Cohen.

[1] Changes in Bodily Form of Descendants of Immigrants, *Washington*, Government Printing Office, 1911 (61st Congress, 2d Session. Senate Document 208). The original data are contained in "Materials for the Study of Inheritance in Man," Columbia University Contributions to Anthropology, Vol. VI.

TABLE 1

Average Statures of Hebrew Boys and Girls

AGE	BOYS		GIRLS	
3.....	.....		93.8±5.7	(18)
4.....	100.6±5.6	(191)	99.4±5.7	(161)
5.....	105.4±6.1	(398)	103.9±5.7	(413)
6.....	110.5±6.5	(412)	109.6±6.3	(442)
7.....	117.1±6.4	(400)	114.9±6.2	(391)
8.....	121.9±6.3	(302)	120.1±6.4	(290)
9.....	126.5±6.5	(233)	125.6±6.1	(225)
10.....	131.3±7.2	(242)	129.7±7.0	(168)
11.....	136.6±7.1	(160)	136.1±7.4	(170)
12.....	139.7±6.9	(110)	140.7±7.7	(116)
13.....	144.5±8.0	(57)	146.4±8.5	(44)
14.....	149.1±7.0	(34)	151.6±4.7	(15)
Total No. of Cases	2547		2453	

Table 2 indicates merely the gradual decrease of stature with increasing age. If there should be any increase with time of birth it would be very slight. I think we may safely say that the stature of Hebrew immigrants has remained the same from 1845 to 1890. This corresponds to the stability of their economic and social condition in Europe during this period.

The condition of the children admitted to the two institutions studied shows, on the contrary, a very considerable increase in stature according to their date of birth. Only observations at the time of admittance were used in Tables 5 and 6 which give the average differences between the stature of the entering child of each age group and the general average for the same age group, for quinquennial periods of date of birth. In Table 4 all ages have been combined.

In the report before referred to I have shown that there are differences in stature between native-born and foreign-born. It was, therefore, necessary to determine for each quinquennial period the percentage of foreign-born and to make a correction for these.

TABLE 2

Stature of Immigrants According to Age

MALES

YEAR OF BIRTH	AGE	HEBREWS	CASES	DEVIATION	SICILIANS	CASES	DEVIATION	BOHEMIANS	CASES	DEVIATION
1890	18-19	.....			.....			.....		
1885-89	20-24	164.11	95	— .06	165.18	83	+ .49	168.13	15	+1.05
1880-84	25-29	164.78	77	+ .61	163.55	65	—1.14	169.38	21	+2.30
1875-79	30-34	164.57	103	+ .40	165.43	89	+ .74	166.20	35	— .88
1870-74	35-39	165.01	109	+ .84	164.01	98	— .68	166.97	74	— .11
1865-69	40-44	164.60	114	+ .43	164.59	75	— .10	167.74	84	+ .66
1860-64	45-49	163.15	92	—1.02	163.70	70	— .99	166.98	56	— .10
1855-59	50-54	162.70	46	—1.47	166.42	55	+1.73	167.29	35	+ .21
1850-54	55-59	163.34	32	— .83	165.67	30	+ .98	165.88	24	—1.20
1845-49	60-64	159.90	10	—4.27	164.00	21	— .69	164.96	25	—2.12
Before 1845	65 & Over	165.60	5	+1.43						
			683			586			369	
	Average		164.17			164.69			167.08	

FEMALES

YEAR OF BIRTH	AGE	HEBREWS	CASES	DEVIATION	SICILIANS	CASES	DEVIATION	BOHEMIANS	CASES	DEVIATION
1890	18-19	155.54	79	+ .74	156.75	79	+1.55	160.75	12	+3.75
1885-89	20-24	156.68	127	+1.88	156.50	108	+1.30	160.77	26	+3.77
1880-84	25-29	154.90	147	+ .10	156.81	122	+1.61	157.71	55	+ .71
1875-79	30-34	155.41	164	+ .61	155.75	134	+ .55	158.06	94	+1.06
1870-74	35-39	154.30	153	— .50	154.38	98	— .82	157.12	127	+ .12
1865-69	40-44	154.30	151	— .50	154.29	106	— .91	157.19	81	+ .19
1860-64	45-49	153.32	97	—1.48	153.34	86	—1.86	155.90	83	—1.10
1855-59	50-54	154.66	35	— .14	153.04	51	—2.16	155.58	48	—1.42
1850-54	55-59	151.93	15	—2.87	153.75	20	—1.45	152.63	16	—4.37
1845-49	60-64	151.75	8	—3.05	150.92	13	—4.28	152.90	20	—4.10
Before 1845	65 & Over	148.71	7	—6.09						
			983			817			562	
	Average		154.80			155.20			157.00	

TABLE 3

Per Cent of Foreign-Born

	BOYS	GIRLS
1895-1899.....	....	30% (206)
1900-1904.....	23% (449)	25% (592)
1905-1909.....	10% (841)	11% (673)
1910-1914.....	7% (692)	5% (574)
1915-1919.....	2% (382)	4% (294)
1920-1924.....	2% (141)	0% (86)

According to the values corrected for the number of foreign-born the changes in stature given in Table 4 result.

I also give the detailed tables for each age (Tables 5 and 6).

Possibly the negative values affecting children measured between 1917-1919 may be due to effects of the War which caused difficulties in normal nutrition. In general, the tables show for each year an increase from the earliest to the latest quinquennium. Even among the poor population of New York a marked increase of stature has oc-

TABLE 4

Deviations From Mean Stature for Quinquennial Periods of Birth of Hebrew Children, All Ages Combined

	BOYS	GIRLS
1892-1894.....	....	—2.90 (33)
1895-1899.....	—4.16 (41)	— .91 (206)
1900-1904.....	—1.31 (449)	+1.76 (592)
1905-1909.....	— .63 (841)	+ .15 (673)
1910-1914.....	+ .22 (692)	+ .96 (574)
1915-1919.....	+1.88 (382)	+2.10 (294)
1920-1924.....	+2.20 (140)	+2.47 (86)

TABLE 5

Hebrew Orphan Asylum and Hebrew Shelter and Guardian Society. Average Deviation From Mean Stature of Age Group in Centimeters. According to Year of Birth. Boys

AGE AT ADMISSION	YEAR OF BIRTH						EXCESS OF NATIVE OVER FOREIGN BORN
	1895-99	1900-04	1905-09	1910-14	1915-19	1920-24	
3.....	....	....	....	....	....	0 8	1.1
4.....	....	−3.6 19	+ .8 56	+2.3 41	− .5 24	+1.0 51	1.1
5.....	....	−1.5 36	− .8 128	+1.0 132	−1.5 64	+2.3 38	1.2
6.....	....	−3.1 68	0 154	+ .5 114	+2.3 49	+3.6 27	1.3
7.....	−5.3 1	−2.8 61	−1.3 129	−1.0 118	+3.6 76	+4.6 15	1.3
8.....	....	−2.8 43	− .3 103	− .5 80	+2.0 74	−2.5 2	1.4
9.....	−5.8 2	− .8 62	− .8 78	− .5 51	+3.1 40	....	1.5
10.....	−6.1 7	+ .3 63	−1.3 82	− .8 58	+4.6 32	....	1.5
11.....	−3.6 5	+ .3 47	0 52	− .3 41	+1.0 14	....	1.6
12.....	−3.1 11	+ .8 30	−1.5 37	+1.8 25	+3.1 7	....	1.7
13.....	−4.1 7	+2.0 13	−4.1 14	+2.0 21	+6.6 2	....	1.8
14.....	−4.1 8	+ .5 7	+2.0 8	+1.5 11	....	....	1.8

TABLE 6

Hebrew Orphan Asylum and Hebrew Shelter and Guardian Society. Average Deviation From Mean Stature of Age Group in Centimeters. According to Year of Birth. Girls

AGE AT ADMISSION	YEAR OF BIRTH							EXCESS OF NATIVE OVER FOREIGN BORN
	1892-94	1895-99	1900-04	1905-09	1910-14	1915-19	1920-24	
3.....	....	....	−1.8 5	+1.0 7	+4.1 6	....	....	3.5
4.....	....	+7.9 5	−3.3 25	0 49	+1.3 28	0 20	+ .8 34	3.2
5.....	....	+2.5 11	−3.6 67	+ .5 121	+ .5 111	− .3 75	+3.8 28	2.9
6.....	....	−2.3 6	−2.0 111	− .3 137	+1.3 120	+1.3 55	+2.0 13	2.6
7.....	+7.1 1	−1.0 19	−1.5 106	+ .3 110	− .3 101	+4.1 44	+5.1 10	2.3
8.....	+3.1 2	−1.0 33	−2.3 84	+ .8 59	+ .5 77	+4.1 34	+4.3 1	1.9
9.....	+1.0 4	−2.3 33	−1.0 58	− .8 63	+1.5 43	+4.6 24	....	1.6
10.....	−2.8 3	−2.0 31	+ .3 50	+1.0 35	+ .5 36	+1.5 13	....	1.3
11.....	−4.3 8	−1.8 36	−2.5 39	+1.5 49	+4.3 24	+1.0 14	....	1.0
12.....	−23.9 1	+ .3 21	+ .8 31	−2.8 37	+3.8 16	+6.9 10	....	.7
13.....	−4.8 9	+ .8 7	−2.0 10	+2.3 6	+1.8 8	+9.4 4	....	.3
14.....	− .8 5	− .5 2	+ .8 5	....	− .5 2	+ .8 1	....	0
15.....	....	+1.3 2	+1.0 1	....	+2.3 2	....	....	−.3

curred between 1892 and 1924. Although here it is demonstrated for children only, there is little doubt that the same increase would be found among these children when adults.

II

I have also investigated the question of the influence of life in the Hebrew Orphan Asylum upon the growth of children. This investigation was first made in 1918 and repeated in 1928 on children entering after 1918. The former investigation had shown that life in the Orphan Asylum affected growth during the first few years unfavorably, and that it took a long time before the loss could be made up. In 1918 the general policy of the Administration was changed. There was less regimentation, a change in diet, more outdoor exercise and an effort to meet the needs of individual children.

The results of the measurements of children at entrance are given in Table 7.

It will be seen that the children placed in charge of the Hebrew Shelter and Guardian Society before 1918 were, at the time of admission, slightly taller than those admitted to the Hebrew Orphan Asylum before 1918. Both groups were shorter than those admitted after 1918.

According to the statement of Mr. Simmonds, the Director of the Asylum, the selection of families before and after 1918 has remained the same. The larger value in the columns "after 1918" must, therefore, be due to the larger statures of those born in later years.

Comparison of the stature at admission with the stature of children after residence shows decided changes. There is no significant difference in the groups belonging to the various half year periods. For this reason I give in Table 8 only the combined results for all ages, the values given being the weighted average differences between the statures of the children of a certain age at the time of admission, and those of children of the same age who have been in residence for a given number of years. In order to avoid a possible source of error I have corrected all measures according to year of birth, based on Table 4. The numbers in parenthesis indicate weights.

The change in bodily development before and after 1918 is striking. Obviously it is not institutional life as such that affects children unfavorably, but the method of management of the institution. Mr. Sim-

TABLE 7

Average Statures of Hebrew Children at Time of Admission to the Hebrew Orphan Asylum (HOA) and the Hebrew Shelter and Guardian Society (HSGS)

AGE	BOYS ADMITTED			GIRLS ADMITTED		
	HSGS Before 1918	HOA Before 1918	HOA After 1918	HSGS Before 1918	HOA Before 1918	HOA After 1918
4.0- 4.5	99.9(44)	.....	98.9(30)	97.2(37)	.....	98.3(26)
4.5- 5.0	101.3(38)	.....	103.4(46)	100.2(27)	.....	101.0(29)
5.0- 5.5	104.1(94)	102.2(28)	104.3(88)	102.1(65)	101.4(75)	104.2(67)
5.5- 6.0	107.0(92)	107.2(45)	107.7(49)	105.3(83)	104.9(63)	105.2(60)
6.0- 6.5	109.6(120)	108.8(47)	110.1(68)	108.4(102)	106.8(88)	109.7(67)
6.5- 7.0	112.6(80)	109.9(46)	113.3(54)	112.4(69)	109.6(75)	113.5(41)
7.0- 7.5	114.9(83)	113.3(47)	118.9(83)	113.2(77)	112.3(85)	116.2(68)
7.5- 8.0	118.0(73)	117.6(58)	119.6(55)	115.9(48)	116.2(75)	118.1(37)
8.0- 8.5	120.5(54)	119.9(50)	121.7(66)	118.1(46)	117.6(58)	121.4(54)
8.5- 9.0	124.7(35)	122.0(40)	124.7(60)	120.6(28)	121.0(63)	122.9(39)
9.0- 9.5	125.3(52)	124.7(35)	126.5(44)	124.8(34)	124.1(52)	127.5(30)
9.5-10.0	127.9(30)	126.0(26)	130.3(41)	124.8(22)	126.0(43)	128.3(37)
10.0-10.5	131.8(42)	129.2(41)	132.3(59)	129.8(26)	128.6(50)	129.2(24)
10.5-11.0	129.7(33)	129.8(21)	133.1(44)	131.4(15)	129.0(27)	131.9(28)
11.0-11.5	131.6(23)	133.7(22)	136.9(43)	131.7(23)	135.0(47)	138.0(27)
11.5-12.0	139.7(28)	134.4(13)	137.5(28)	136.2(16)	135.5(32)	141.0(24)
12.0-12.5	139.9(21)	138.7(13)	138.5(28)	138.9(15)	138.4(30)	140.2(28)
12.5-13.0	140.5(12)	136.6(9)	142.4(24)	146.3(5)	140.8(18)	144.1(21)
13.0-13.5	144.9(19)	.....	144.3(22)	143.5(8)	145.9(12)	148.1(11)
13.5-14.0	144.8(4)	.....	147.8(10)	143.5(2)	146.8(10)	152.2(7)
14.0-14.5	148.4(9)	.....	150.0(14)	152.4(5)	150.3(6)	156.0(2)
14.5-15.0	145.2(6)	.....	158.1(4)	.....	152.4(2)	140.0(1)

monds, the Executive Director, summarizes the changes that have been made since 1918 as follows:

1. Since 1918, special attention has been paid to the diet; coffee and tea have been eliminated—milk and cocoa have been substituted. Crackers and milk are served to the children attending school within the building at ten o'clock every school morning and at three o'clock to all children.

2. A more balanced diet has been instituted, especially the introduction of green-leaved foods. The Russian children are not very fond of these foods, but we finally won out.

3. There has been curtailment of hours spent in classrooms after three o'clock.

4. Camping experience is given to all children above the age of seven years. Minimum length of stay at camp is about three-and-a-half weeks.

5. There has been an increase in rest periods.

6. Increased recreational facilities have been installed.

7. There have been more contacts with the community.

8. There has been brought about the elimination of isolated visiting days, making every day visiting day and the children visit their folks on the average of three or four times a month.

9. The introduction of the Child Guidance Clinic has done much to solve most of the problems of the children.

The attending physician, Dr. William Friedman, adds to this the following more detailed statement regarding medical care:

The changes which have taken place in the physical care of the wards of the Hebrew Orphan Asylum since 1918 are as follows:

The first innovation was to install a completely new record system containing the previous history of the inmate, the initial examination, and the semi-annual physical examination. In this manner a complete check-up has been made of the physical status of each child semi-annually. Besides this the children are weighed approximately every month and in this manner progress of the child is noted.

It has been the policy of the medical department to attach itself to the various medical agencies throughout the greater city. In this manner it avails itself of the various types of treatment which can be obtained in these clinics.

Every child in the institution goes to our summer camp for at least one month every year. Children who we think will be benefited by country environment are sent away for as long as six months to two year periods. During the summer we maintain a separate camp at Edenwald which is used daily for small groups of younger children from the institution. Here there are athletic fields, swimming pool, etc. About six years ago a very splendid gift the "Warner Memorial Gymnasium" was built for the institution where the children indulge in various activities.

The diet has been carefully watched and is inspected weekly by the physicians. Our foods, such as milk, are analyzed regularly; the meat and butter are inspected by the government at stated periods.

Dr. J. Novikoff reports in regard to dental care:

The Dental Clinic was established in the fall of 1918. Prior to that time the dental care consisted of unsystematic examination and very inadequate dental procedure.

With the establishment of an efficient dental department, a great many foci of infection of oral origin have been eliminated.

The systematic care of the oral cavity has eliminated sore mouths which were due to aching teeth and faulty hygiene. The stressing of a healthy oral condition has been helpful in maintaining general good health, through the elimination of focal infection and better mastication; to that effect the dental department has made a large contribution.

The psychiatrist, Dr. Samuel Z. Orgel, adds the following remarks:

The psychiatrist sees only the more difficult types of children for treatment, those for whom all attempts of adjustment to the group have proved futile. All of the children referred to the psychiatrist are either mal-nourished or suffering from symptoms referable to the digestive tract, and of emotional origin. In the course of investigation and treatment it appears that if these conditions were allowed to persist untreated they would ultimately lead to malnutrition and all its ill effects. In helping these children to solve their emotional problems, relieving their anxieties, fears, angers, feelings of rejection from whatever cause, we are providing them with a healthy and proper perspective on life. Our treatment aims not only

TABLE 8

Hebrew Orphan Asylum. Differences Between Stature at Time of Admission (E) and Statures After Periods of Residence (R) (R—E) in Cm. Averages for All Ages

PERIOD OF RESIDENCE	ADMITTED BEFORE 1918		ADMITTED AFTER 1918	
	Boys	Girls	Boys	Girls
.5- 1.0	.....	.....	.0(300)	+ .9(228)
1.0- 1.5	—1.0(328)	— .9(487)	+ .4(275)	+1.2(190)
1.5- 2.0			+ .5(245)	+1.9(168)
2.0- 2.5	—1.7(298)	—1.6(440)	+ .6(230)	+1.6(149)
2.5- 3.0			— .2(192)	+1.0(129)
3.0- 3.5	—1.6(230)	—2.0(347)	— .1(169)	+1.0(119)
3.5- 4.0			+ .5(159)	+ .9(116)
4.0- 4.5	—2.0(173)	—1.5(266)	+ .7(141)	+2.0(110)
4.5- 5.0			+ .8(135)	+1.1(97)
5.0- 5.5	—1.1(124)	— .9(200)	+ .6(106)	+2.4(79)
5.5- 6.0			+ .8(93)	+2.4(77)
6.0- 6.5	— .6(77)	— .6(140)	+ .6(75)	+1.7(59)
6.5- 7.0			+1.0(60)	+2.0(52)
7.0- 7.5	± .0(42)	— .2(90)	+2.2(49)	+1.2(37)
7.5- 8.0			+2.0(38)	+ .8(24)
8.0- 8.5	+ .9(20)	— .1(47)	+2.7(28)	+3.4(19)
8.5- 9.0			+3.6(18)	+1.2(13)
9.0- 9.5	+4.0(13)	+ .7(23)	+2.3(12)	+2.3(8)
9.5-10.0			+6.0(6)	+6.4(3)
10.0-10.5	.....	+1.1(7)	+9.6(3)	+1.8(5)
10.5-11.0			+12.6(1)	+5.6(1)

at the alleviation of the acute episode for which the child has been referred to us but also at a determination of additional factors underlying this type of reaction, so that a cure can be brought about and any possibility of future suffering for the child be eliminated. This method is followed in the case of children placed in foster homes and for those in the Institution. Both require the same type of approach and treatment. The placement of a child in a foster home does not by itself remove the underlying motivating factors in the child's behavior. Often the psychological situation established in the foster home may help to alleviate the acute condition and allow the child to solve his own problem. Here too it is observed that the basic approach is through the emotions and that the consumption of food and its proper digestion are but secondary to the clearing up of the child's emotional conflicts. In spite of our lack of height and weight charts to give tangible proof of the correctness of our assumptions we feel that since the Psychiatric Department has been in existence it has proven itself a helpful adjuvant to diet, regimentation, school hours, and individual care, whether this help has been given directly to the child or indirectly through other individuals caring for the child.

The influence of residence in the Hebrew Shelter and Guardian Society, which is managed on a cottage system, was quite different. For the children admitted before 1918 the values given in Table 9 for all combined ages were found.

The difference in the development of boys and girls is striking.

TABLE 9

Hebrew Shelter and Guardian Society. Differences Between Stature at Time of Admission (E) and Statures After Period of Residence (R) (R—E). Time of Residence R—E.

RESIDENCE	BOYS	GIRLS
Admission	.0	.0
1 year	+ .31(227)	+ .13(186)
2 years	— .59(187)	+ .64(164)
3 years	— .39(109)	+1.26(98)
4 years	+ .02(72)	+2.33(54)
5 years	+ .13(41)	+5.64(31)

III

CHANGES IN WIDTH OF FACE AMONG IMMIGRANTS

In my report on Changes in Bodily Form of Immigrants, pp. 114, 115, I called attention to the decrease of the width of face among Bohemian

TABLE 10

Average Width of Face of Immigrants According to Year of Immigration

MALES

YEAR OF IMMIGRATION	MEASURED 1909								MEASURED 1926				AVG. OF ALL 1909 MEASUREMENTS		DEV. FROM TOTAL AVG.
	Hebrews		Bohemians		Central Italians		Sicilians		Central Italians		Sicilians				
1870-74	....	...	.....	...	143.67	3	.....	...	.....	..	.....	..	143.67	3	+3.34
1875-79	....	...	.....	...	146.86	7	140.00	2	.....	..	.....	..	145.34	9	+5.01
1880-84	139.7	30	144.54	90	141.25	28	139.75	8	135.00	1	.....	..	142.77	156	+2.44
1885-89	140.2	70	143.27	83	141.59	59	139.19	21	136.75	4	137.76	4	141.55	233	+1.22
1890-94	140.1	128	142.87	71	140.88	69	139.79	70	139.57	7	140.50	10	140.78	338	+ .45
1895-99	139.6	87	142.73	32	139.71	73	139.08	112	141.18	11	139.30	10	139.76	304	— .57
1900-04	139.9	211	142.51	69	140.54	97	138.64	176	141.84	25	139.00	34	139.94	553	— .39
1905-09	139.1	206	140.33	61	140.27	54	138.36	116	140.50	10	136.87	39	139.22	437	—1.11
1910-14	....	...	.....	...	.....	...	.....	...	141.58	12	137.93	27	.....	...	.....
1915-19	....	...	.....	...	.....	...	.....	...	142.00	1	131.40	5	.....	...	.....
1920-24	....	...	.....	...	.....	...	.....	...	.....	..	139.00	7	.....	...	.....
		732		406		390		505		71		136	2033 Cases		Average 140.33

FEMALES

YEAR OF IMMIGRATION	MEASURED 1909								MEASURED 1926				AVG. OF ALL 1909 MEASUREMENTS		DEV. FROM TOTAL AVG.
	Hebrews		Bohemians		Central Italians		Sicilians		Central Italians		Sicilians				
1875-79	....	...	.....	...	136.57	7	.....	...	.....	..	.....	..	136.57	7	+3.59
1880-84	136.6	31	136.36	106	136.27	22	136.00	2	.....	..	143.50	2	136.39	161	+3.41
1885-89	133.8	91	135.48	118	134.40	73	132.17	39	133.67	3	135.00	1	134.36	321	+1.38
1890-94	133.5	161	133.71	163	133.77	100	131.88	64	134.44	9	135.72	7	133.41	488	+ .43
1895-99	133.0	75	133.89	59	133.29	113	132.04	138	131.38	13	130.37	22	132.88	385	— .10
1900-04	132.0	244	133.86	91	131.82	149	131.38	221	136.28	25	132.32	46	132.01	705	— .97
1905-09	131.90	233	134.73	64	131.69	100	131.62	184	133.41	22	131.59	48	132.09	581	— .89
1910-14	....	...	.....	...	.....	...	.....	...	134.32	28	132.13	46	.....	...	.....
1915-19	....	...	.....	...	.....	...	.....	...	135.80	5	131.71	7	.....	...	.....
1920-24	....	...	.....	...	.....	...	.....	...	134.75	4	132.42	12	.....	...	.....
		835		601		564		648		109		191	2648 Cases		Average 132.98

TABLE 11

Average Width of Face of Immigrants According to Age

MALES

AGE	MEASURED 1909								MEASURED 1926				AVG. OF ALL 1909 MEASUREMENTS		DEV. FROM TOTAL AVG.
	Hebrews		Bohemians		Central Italians		Sicilians		Central Italians		Sicilians				
25-29	138.56	81	141.62	21	140.35	34	137.01	67	.....	..	138.45	11	138.66	203	—1.77
30-34	139.72	105	139.53	36	139.47	70	138.19	90	141.56	9	139.36	22	139.18	301	—1.25
35-39	140.42	110	142.63	78	139.17	63	137.79	95	140.36	11	135.75	24	139.97	346	— .46
40-44	140.58	116	143.93	84	139.65	69	140.55	71	141.79	14	137.94	33	141.21	340	+ .78
45-49	140.64	96	143.46	61	140.87	71	139.25	71	139.72	18	137.94	18	140.94	299	+ .51
50-54	141.42	48	141.95	38	141.96	53	140.16	55	141.40	10	140.79	14	141.31	194	+ .88
55-59	142.81	31	146.19	21	140.50	26	141.07	30	141.40	5	139.50	8	142.43	108	+2.00
60-64	140.64	11	143.67	18	143.50	10	141.46	13	137.50	2	139.80	5	142.44	52	+2.01
65 & Over	141.60	5	141.75	8	140.78	9	135.86	7	135.50	2	137.83	6	140.00	29	— .43
		603		365		405		499		71		141	1872 Cases		Average 140.43

FEMALES

AGE	MEASURED 1909								MEASURED 1926				AVG. OF ALL 1909 MEASUREMENTS		DEV. FROM TOTAL AVG.
	Hebrews		Bohemians		Central Italians		Sicilians		Central Italians		Sicilians				
25-29	132.29	145	134.98	53	131.64	87	131.37	120	133.46	13	132.92	25	132.23	405	—1.14
30-34	132.48	162	135.34	93	133.14	105	131.10	136	135.40	20	131.09	47	132.78	496	— .59
35-39	133.84	146	135.13	121	132.59	105	132.25	100	135.18	22	131.95	44	133.56	472	+ .19
40-44	134.46	146	135.35	80	133.56	94	131.25	110	132.38	26	132.65	43	133.61	430	+ .24
45-49	133.17	94	135.93	80	135.76	70	132.86	85	134.12	17	131.71	17	134.31	329	+ .94
50-54	134.69	36	137.07	45	133.30	40	132.87	53	136.00	10	134.10	19	134.43	174	+1.06
55-59	133.29	17	137.76	17	132.38	13	133.90	20	135.50	2	134.00	4	134.43	67	+1.06
60-64	134.67	9	137.40	10	133.36	11	132.57	7	.....	..	129.00	2	134.62	37	+1.25
65 & Over	133.14	7	133.30	10	130.83	12	132.17	6	138.50	2	132.25	4	132.23	35	—1.14
		762		509		537		637		112		205	2445 Cases		Average 133.37

immigrants arriving at various periods. At that time I had calculated data only for Bohemians. I give here the data for Hebrews and Italians also. A series of Italians measured in 1926 is added, but the number of cases is too small to give clear results. These data are presented in Table 10, the last column of which shows a constant decrease for the combined groups from 1875 to 1910.

It might seem that we are dealing here with a peculiar kind of selection. On the other hand it seemed plausible that age changes may be involved, since the early immigrants are, on the average, older than recent immigrants. I have, therefore, rearranged the material according to age groups (Table 11).

It appears from this table that there is a decided increase of the bizygomatic width of face with age.

It is impossible to determine from the available data the cause of this phenomenon which may be due to a true, individual increment, to a higher mortality of those with narrower faces, to selection in immigration, or to a change in the character of the European population. The only way to decide which of these causes brings about the peculiar result is by continued observations of the same individual and by studies of a stable population. The observations on the width of face of Bohemians given in my Report on Changes in the Bodily Form of Immigrants (p. 73), show a remarkable instability of this feature, which might suggest that changed conditions of life in Europe bring about changes of this trait, but this is contradicted by the observation of stature of immigrating Hebrews noted earlier in this paper. Still, it is worth investigating whether there may not be a general tendency to greater leptosomy in modern populations.

ANTHROPOMETRIC STUDIES OF INDIVIDUAL GROWTH

I. AGE, HEIGHT, AND RATE OF GROWTH IN HEIGHT, ELEMENTARY SCHOOL CHILDREN*

BY CARROLL E. PALMER AND LOWELL J. REED

INTRODUCTION

SINCE the first appearance of systematic studies of the physical growth of human beings, a succession of competent workers has maintained [1] that completely satisfactory knowledge of age-changes in the living human body can be obtained only by observing a group of the *same individuals during the period of their growth.* Such a view, on a priori grounds, scarcely needs to be defended; it is sufficiently obvious that the most direct, and therefore probably the most efficient, method of determining the changes which take place in the growing body during a given interval of time involves the continued or repeated observation of that body. Because of the practical difficulties of obtaining long series of repeated measurements of human beings, investigators, with very few exceptions, have been forced to adopt an alternative and generally less efficient method of studying age-changes or growth. This alternative method is based

* From the Department of Biostatistics (Paper No. 201) of the School of Hygiene and Public Health, The Johns Hopkins University; and the Office of Field Investigations in Child Hygiene, U. S. Public Health Service. The investigation during which the data used in this paper were collected was begun under the direction of Asst. Surgeon General Taliaferro Clark, formerly in charge of Field Investigations in Child Hygiene, U. S. Public Health Service. The field observations were made under the immediate supervision of Surgeon C. V. Akin. The writers are indebted to these officers and to Senior Statistician Selwyn D. Collins, of the Public Health Service, for assistance in the interpretation of the data.

[1] Numerous expositions from various points of view are to be found in the literature. The interested reader is referred in particular to the early work of Combe (1), and Boas (2) and the more recent papers by Guttmann (3) and Merrell (4).

on the assumption that age-changes are the differences between groups of different individuals measured at different ages. This assumption, that differences between successive age groups represent age-changes, is justified, of course, only if each age group is completely representative of the specific population being studied. If for any reason certain types of individuals are more likely to be selected in one group than in another, part of the observed differences between successive classes may be due to this differential selection. In practical work it is often impossible to determine whether or not differential selection is present; and in most cases it is impossible to measure quantitatively its effect although its presence may be known or suspected.

In addition to the errors introduced by differential selection the study of growth changes by this method is quite limited. It is, for example, impossible to answer such pertinent questions as: What is the association or correlation between growth in a given period and size already attained? or, What is the correlation between growth in one period and growth at some later or previous period? In spite of such deficiencies and limitations it is safe to say that by far the greatest part of present day knowledge of human growth has been derived through the application of this "average" or "cross section" method, as the procedure of analyzing measurements of different individuals has come to be designated. On the other hand, only the most meager information is available from studies based on the "individual" or "longitudinal" method. That such should be the case is the more or less obvious consequence of the difficulties of obtaining repeated measurements on any considerable numbers of the same individuals. At the present time, however, repeated observations on the same individuals have been collected by a few investigators and some workers have been able to institute programs which involve measuring the same children year after year during their growth. With the collection of such data, the question has arisen, naturally, of the possible methods of analysis. These methods will depend to some extent on the length of time over which the measurements are taken. If long series of observations are available it will be found advisable, probably, to derive individual growth curves and thus to make the final analysis of growth in terms of the parameters or mathematical characteristics of these curves. On the other hand, if only short consecutive series can be obtained it probably will not be appropriate to fit individual growth curves and other methods of analysis will be required. With the exception of the work of a few

investigators, for example Boas (5), little attention has been given to the wide variety of different methods[2] that may be utilized and the number of different facts, in many instances entirely new facts, which even short series of repeated measurements may be expected to give. Therefore, in addition to the presentation of certain detailed facts of growth, it is proposed in this series of papers to show how very short series of repeated measurements may be made to yield reliable and, in some instances, new information as regards growth. In this, the first paper, an analysis of individual annual increments or individual annual rates of growth in height of elementary school children is presented. By means of the analysis it is proposed to answer, in some detail, two general questions which may be stated broadly as follows: First; Is the rate of growth in height of an individual related to his absolute height and, if so, does this relationship change with age? Second; To what extent do individuals, who were alike with respect to height at one age, tend to become different after a year of growth, or, expressed in another way; What is the dispersing effect of growth?

MATERIAL

The material used in the paper was collected during an extensive investigation of growth and health of school children made by the U. S. Public Health Service at Hagerstown, Maryland. Part of this investigation consisted of making annual measurements of standing height of nearly all of the white native-born children attending the elementary grade schools from 1922 to 1928. During this interval some children were measured once, some twice, and so on; a few being measured seven times. The observations used consist of measurements of height of 1,254 different boys and 1,160 girls; measured annually for four or more successive years. The number of measurements included is 12,170, thus giving an average of slightly more than five annual observations per child. The data, although selected, are considered representative of the school population, the only known selective elements being those which would require a child to be present in school on the four annual days of measuring.

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[2] An example of the rather limited use of data of this type will be found in reference (6).

Heights were determined with the individual in the erect position, without shoes. The procedure prescribed by Hrdlička[3] (7) was followed in detail. Measurements were read and recorded to the nearest quarter inch and subsequently grouped to the nearest whole inch for the purpose of the analysis. It was impossible in a study of this magnitude to measure the children at exactly twelve-month intervals, but all measurements were reduced to full yearly intervals by arithmetical interpolation. With few exceptions the intervals between actual measurements were between 11 and 13 months. The dates of birth of the children were obtained from the school records and age was classified as of the birthday nearest January first of the year of measurement.

Approximately 90 per cent of the measurements used were made by the same person using the same stadiometer. Thus it was assumed that errors due to the "personal equation" were of minor importance. Errors introduced by diurnal and seasonal variations were not well controlled. However, all measurements were made after school convened at 9 a. m. and because diurnal changes are greatest during the first hour or two after arising, it is likely that variations due to differences in the hour of measuring were not large. In most instances the annual measurements were made in the spring, thus coinciding with the season of most rapid growth in height. It is certain that some variation will arise as a result of making simple arithmetical interpolations for the differences in numbers of days between measurements. Unfortunately, it is impossible now to correct for or to evaluate quantitatively the effect of this error.

METHOD

The method of analyzing the data is essentially one of correlation, the particular relationship of interest being that between attained height at the beginning of the year and the gain in height during the following year. This relationship has been expressed in terms of regression lines. Thus, after grouping the children into age and sex specific classes and then into subgroups containing only individuals of the same height (within one inch) two constants were calculated for the measurements of children in each of the subgroups; first, the average annual gain or the mean annual growth in height in inches during the following year

[3] Grateful acknowledgement is made to Dr. Hrdlička for personal assistance in this part of the work.

TABLE 1

Constants of Frequency Distributions of Annual Gains in Height, for Specified Ages and Heights, Elementary School Boys, Hagerstown, Maryland. (Measurements Made in the Spring Months of 1928-1929)

TABLE I

Constants of Frequency Distributions of Annual Gains in Height, for Specified Ages and Heights, Elementary School Boys, Hagerstown, Maryland. (Measurements Made in the Spring Months of 1922-1928)

AGE CLASS *	CONSTANTS OF DISTRIBUTION OF GAINS	HEIGHT (inches)																				ALL HEIGHTS, FOR SPECIFIED AGE
		42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	
6- 7	Mean (inches)	2.38	2.31	2.28	2.45	2.50	2.19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2.37
	Standard deviation	.52	.56	.34	.72	.52	.67	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.56
	Number of cases	16	32	36	40	38	16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	178
7- 8	Mean (inches)	...	2.06	2.26	2.21	2.32	2.26	2.23	2.22	2.22	...	...	...	...	...	...	...	...	...	...	...	2.24
	Standard deviation	...	.53	.51	.47	.55	.44	.71	.52	.56	...	...	...	...	...	...	...	...	...	...	...	.54
	Number of cases	...	33	54	87	107	92	78	45	27	...	...	...	...	...	...	...	...	...	...	...	523
8- 9	Mean (inches)	...	...	2.38	2.14	2.21	2.12	2.23	2.05	2.17	2.22	2.31	2.00	...	...	...	...	...	...	...	...	2.16
	Standard deviation	...	...	.56	.64	.48	.48	.54	.49	.53	.54	.42	.47	...	...	...	...	...	...	...	...	.50
	Number of cases	...	...	13	37	70	95	124	128	109	68	36	20	...	...	...	...	...	...	...	...	700
9-10	Mean (inches)	...	...	...	...	2.14	1.89	2.00	1.99	1.96	1.99	2.09	1.93	2.07	2.07	...	...	...	...	...	...	2.00
	Standard deviation	...	...	...	...	.43	.54	.42	.44	.35	.43	.50	.50	.46	.52	...	...	...	...	...	...	.45
	Number of cases	...	...	...	...	14	36	91	119	132	152	113	84	44	28	...	...	...	...	...	...	813
10-11	Mean (inches)	...	...	...	...	...	...	1.80	2.02	1.97	1.88	1.97	2.02	1.99	2.06	2.23	2.12	...	...	...	...	1.99
	Standard deviation	...	...	...	...	...	...	.53	.48	.53	.41	.44	.48	.41	.49	.38	.70	...	...	...	...	.46
	Number of cases	...	...	...	...	...	...	20	41	91	121	128	125	100	83	39	17	...	...	...	...	765
11-12	Mean (inches)	...	...	...	...	...	...	...	...	1.69	2.05	1.79	1.86	1.97	1.94	2.00	1.98	2.26	2.31	...	...	1.95
	Standard deviation	...	...	...	...	...	...	...	...	.62	.68	.54	.52	.53	.59	.38	.51	.52	.80	...	...	.54
	Number of cases	...	...	...	...	...	...	...	...	16	41	85	104	101	96	79	55	38	16	...	...	631
12-13	Mean (inches)	...	...	...	...	...	...	...	...	...	...	...	1.89	1.96	2.22	2.14	2.35	2.40	2.68	2.59	...	2.23
	Standard deviation	...	...	...	...	...	...	...	...	...	...	...	.50	.59	.78	.75	.83	.75	1.01	1.08	...	.77
	Number of cases	...	...	...	...	...	...	...	...	...	...	...	35	55	81	76	55	60	25	22	...	409
13-14	Mean (inches)	...	...	...	...	...	...	...	...	...	...	...	...	...	2.22	2.41	2.26	2.75	2.61	2.77	3.00	2.59
	Standard deviation	...	...	...	...	...	...	...	...	...	...	...	...	...	.83	1.16	.79	.96	1.00	1.25	.82	.99
	Number of cases	...	...	...	...	...	...	...	...	...	...	...	...	...	23	27	31	44	31	30	24	210
ALL AGES FOR SPECIFIED HEIGHT—																						
	Mean (inches)	2.38	2.18	2.28	2.25	2.31	2.14	2.13	2.05	2.03	2.01	2.00	1.94	1.99	2.08	2.14	2.18	2.47	2.57	2.69	3.00	...
	Standard deviation	.52	.55	.46	.60	.52	.49	.56	.48	.48	.48	.48	.50	.50	.64	.66	.71	.77	.96	1.18	.82	...
	Number of cases	16	65	103	164	229	239	313	333	375	382	362	368	300	311	221	158	142	72	52	24	...

* The first figure in the age class represents the age (nearest January 1st) at the beginning of the interval in which the gain was made, the second figure, the age at the end of the interval.

TABLE 2

Constants of Frequency Distributions of Annual Gains in Height, for Specified Ages and Heights, Elementary School Girls, Hagerstown, Maryland. (Measurements Made in the Spring Months of 1922-1928)

AGE CLASS *	CONSTANTS OF DISTRIBUTION OF GAINS	HEIGHT (inches)																						ALL HEIGHTS, FOR SPECIFIED AGE
		42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	
6- 7	Mean (inches)	2.45	2.12	2.33	2.30	2.33	2.43	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2.30
	Standard deviation	.51	.64	.42	.58	.37	.40	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.49
	Number of cases	20	26	51	37	27	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	175
7- 8	Mean (inches)	2.31	2.38	2.27	2.18	2.18	2.21	2.22	2.30	2.10	...	...	...	...	...	...	...	...	...	...	...	...	...	2.23
	Standard deviation	.36	.75	.50	.59	.49	.55	.62	.57	.45	...	...	...	...	...	...	...	...	...	...	...	...	...	.59
	Number of cases	16	34	75	87	101	91	67	30	10	...	...	...	...	...	...	...	...	...	...	...	...	...	511
8- 9	Mean (inches)	...	...	2.09	2.16	2.12	2.14	2.15	2.19	2.18	2.18	1.96	...	...	...	...	...	...	...	...	...	...	...	2.15
	Standard deviation	...	...	.85	.61	.52	.48	.50	.48	.46	.38	.70	...	...	...	...	...	...	...	...	...	...	...	.52
	Number of cases	...	...	22	37	81	115	115	115	82	49	26	...	...	...	...	...	...	...	...	...	...	...	642
9-10	Mean (inches)	...	...	...	2.00	2.00	1.94	2.08	2.10	2.11	2.05	2.17	2.21	2.18	2.40	...	...	...	...	...	...	...	...	2.10
	Standard deviation	...	...	...	.36	.51	.42	.52	.53	.56	.52	.53	.54	.53	.60	...	...	...	...	...	...	...	...	.52
	Number of cases	...	...	...	19	23	50	85	127	131	133	100	67	28	10	...	...	...	...	...	...	...	...	773
10-11	Mean (inches)	...	...	...	...	...	2.22	2.11	2.00	2.01	2.14	2.24	2.35	2.53	2.65	2.70	2.77	...	...	...	...	...	...	2.29
	Standard deviation	...	...	...	...	...	.66	.39	.43	.60	.66	.59	.57	.62	.66	.77	.63	...	...	...	...	...	...	.63
	Number of cases	...	...	...	...	...	23	28	53	78	125	128	120	91	63	30	13	...	...	...	...	...	...	752
11-12	Mean (inches)	...	...	...	...	...	...	...	2.00	2.00	2.27	2.31	2.43	2.54	2.74	2.66	2.84	2.61	2.64	...	...	...	...	2.52
	Standard deviation	...	...	...	...	...	...	...	.50	.63	.60	.54	.74	.66	.77	.81	.71	.61	.93	...	...	...	...	.70
	Number of cases	...	...	...	...	...	...	...	12	33	48	62	77	89	88	73	49	36	25	...	...	...	...	592
12-13	Mean (inches)	...	...	...	...	...	...	...	...	...	2.08	2.52	2.52	2.77	2.93	2.67	2.66	2.28	2.54	2.31	2.13	...	...	2.57
	Standard deviation	...	...	...	...	...	...	...	...	...	.70	.65	.54	.83	.68	.69	.86	.88	.65	.72	.81	...	...	.75
	Number of cases	...	...	...	...	...	...	...	...	...	12	23	31	44	55	42	61	40	39	36	16	...	...	399
13-14	Mean (inches)	...	...	...	...	...	...	...	...	...	...	...	...	2.93	2.55	2.22	2.23	2.12	2.04	1.93	1.59	1.38	1.23	1.99
	Standard deviation	...	...	...	...	...	...	...	...	...	...	...	...	.52	.59	.93	.69	.83	.75	.94	.89	.81	.75	.80
	Number of cases	...	...	...	...	...	...	...	...	...	...	...	...	14	11	18	26	33	26	29	22	24	13	216
ALL AGES FOR SPECIFIED HEIGHT—																								
	Mean (inches)	2.39	2.27	2.26	2.18	2.16	2.15	2.14	2.13	2.10	2.13	2.23	2.36	2.56	2.74	2.62	2.65	2.34	2.42	2.14	1.82	1.38	1.23	...
	Standard deviation	.45	.70	.54	.57	.49	.51	.59	.50	.55	.57	.58	.61	.73	.70	.79	.77	.78	.76	.82	.86	.81	.75	...
	Number of cases	36	60	148	180	232	293	295	337	334	367	339	295	266	227	163	149	109	90	65	38	24	13	...

* The first figure in the age class represents the age (nearest January 1st) at the beginning of the interval in which the gain was made, the second figure the age at the end of the interval.

and, second, the standard deviation of the annual gains. The average annual gains thus determined define the regression line and the standard deviations show the degree of the individual variability about the line.

Basic data [4] showing the average and standard deviations of annual gains in height for children of given age, sex and height are shown in Tables 1 and 2. A specific example of the method of reading the values given there may facilitate the interpretation of the tables. In the upper left hand corner of Table 1, vertically under the caption 42, are given three items, mean, standard deviation and number of cases, which refer to the age class 6-7. These three values show that 16 boys, 42 inches tall at 6 years of age, gained an average of 2.38 inches between their 6th and 7th year and that the standard deviation of the frequency distribution of these gains equaled 0.52 inches. The numbers in the vertical margin at the extreme right in Tables 1 and 2 are the weighted mean and weighted standard deviation of the annual gains for the different age classes, *irrespective of height at those ages;* the numbers given in the lowest horizontal sections of these tables are, similarly, the weighted values of mean and standard deviation of gains of individuals of the same height *irrespective of age.*

MEAN ANNUAL RATES OF GROWTH

The relationship between height at the beginning of the year and growth during the following year is shown graphically in the upper sections of Figures 1 and 2. For boys (upper section, Figure 1), it will be observed that gains from the 6th to 7th, 7th to 8th, 8th to 9th, and 9th to 10th years decrease with advancing age, that is, the line representing growth during the 7th to 8th year is placed below that for the 6th to the 7th year; the line for the 8th to the 9th year is below that for the 7th to the 8th year, and so on. It will be noted also, despite some irregular fluctuations, that these lines are approximately horizontal or that very nearly the same actual gain is made during a particular year, irrespective of the absolute height of the individuals at the beginning of the year. Thus it appears that growth in height during the 6th to the 10th year depends largely on age and that increase in stature is more or less independent of actual size. During the interval between the 10th and 11th year, particularly for boys that are above 52 or 53 inches

[4] Data for subgroups containing less than 12 cases are omitted. In calculating the standard deviations Sheppard's correction for the effect of grouping was used.

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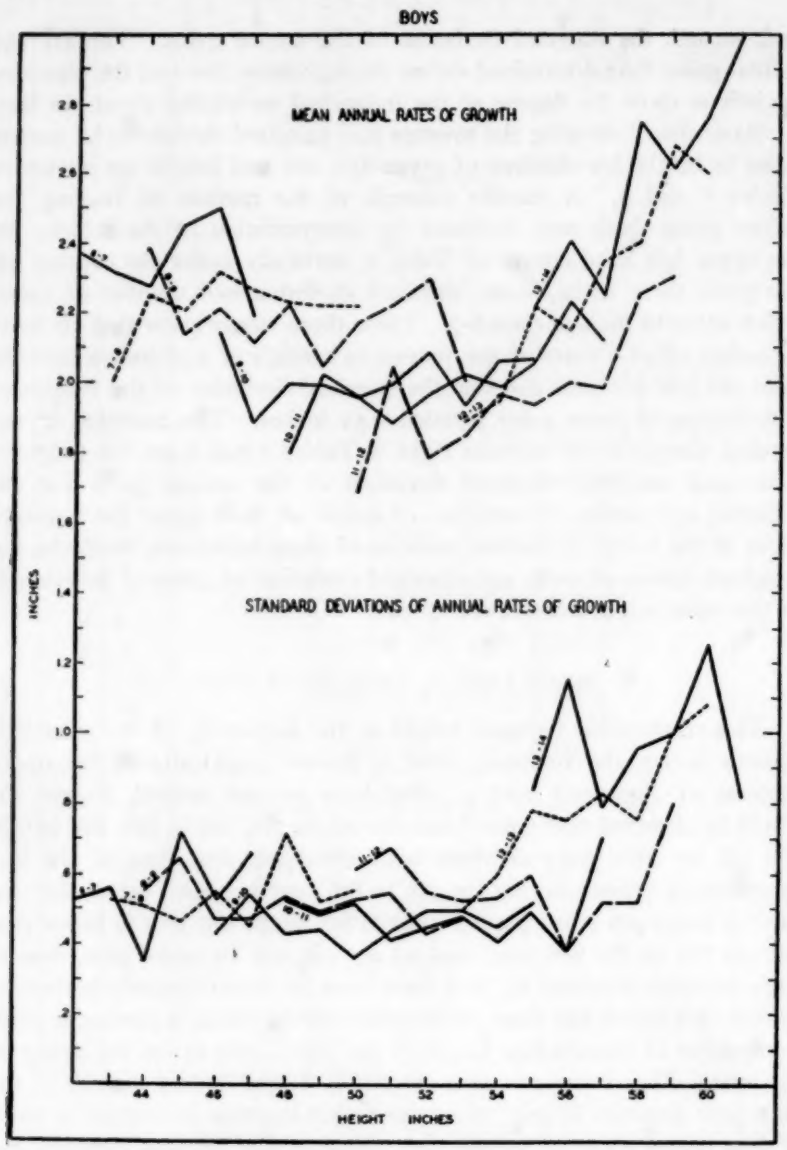

FIG. 1. REGRESSION LINES SHOWING THE MEAN ANNUAL RATES OF GROWTH IN HEIGHT (INCHES PER YEAR) AND STANDARD DEVIATIONS OF ANNUAL RATES OF GROWTH OF ELEMENTARY SCHOOL BOYS OF SPECIFIED HEIGHT.

The small numbers placed beside the lines indicate the age interval for which the rates apply.

in height, it is evident that the taller boys are growing more rapidly than the shorter ones. When the 11th year is reached, and thereafter as far as the data in this study extend, there is a definite and direct association between annual increments of height and height itself. It is clear, in fact, that during the period between the 11th and 14th year growth in height depends very much on actual height. Study of the lines representing the various age classes suggests the further fact that when boys reach a height of 52-53 inches an acceleration in their growth occurs which is to a large extent independent of their age. Thus the lines for the various age groups tend to remain roughly horizontal for boys that are less than 53 inches tall. After that stature is reached, most of the lines show an upward inclination indicating that with increasing stature there is a corresponding increase in the average annual gain or rate of growth.

In order to smooth the irregular fluctuations of the lines given in Figure 1, straight lines were fitted to them by the method of least squares. The resulting equations, together with the standard deviations of the slope constants, are given in Table 3. The slope constants of these lines, evaluated in terms of their deviations from zero are of particular interest. For the four age classes from the 6th to the 10th year these constants are small and reference to their standard deviations shows that the lines are not significantly inclined from a horizontal position. This finding quantitatively substantiates the fact that during the 6th to the 10th year the gain which a boy makes during the following year is not influenced by his stature at the beginning of the year. The slope constants of the fitted lines for the 10th year and forward are significantly greater than zero, thus verifying the observation that during the adolescent period the rate of growth is associated significantly with actual height.

Considering now the analysis of the data for girls, the upper section of Figure 2 shows for the separate age classes the relationship between the rate of growth and attained height. For the first three age groups these relationships are similar to those for boys of the same age, there being little association between rate of growth and actual height. During the 9th and 10th years, girls above 51 inches in height appear to grow more rapidly than those less than 51 inches. During the 10th and 11th years the relationship between size and rate of increase in size becomes evident and it is seen that an attained height of 51 inches appears as a turning point or critical stage of growth. The curve of

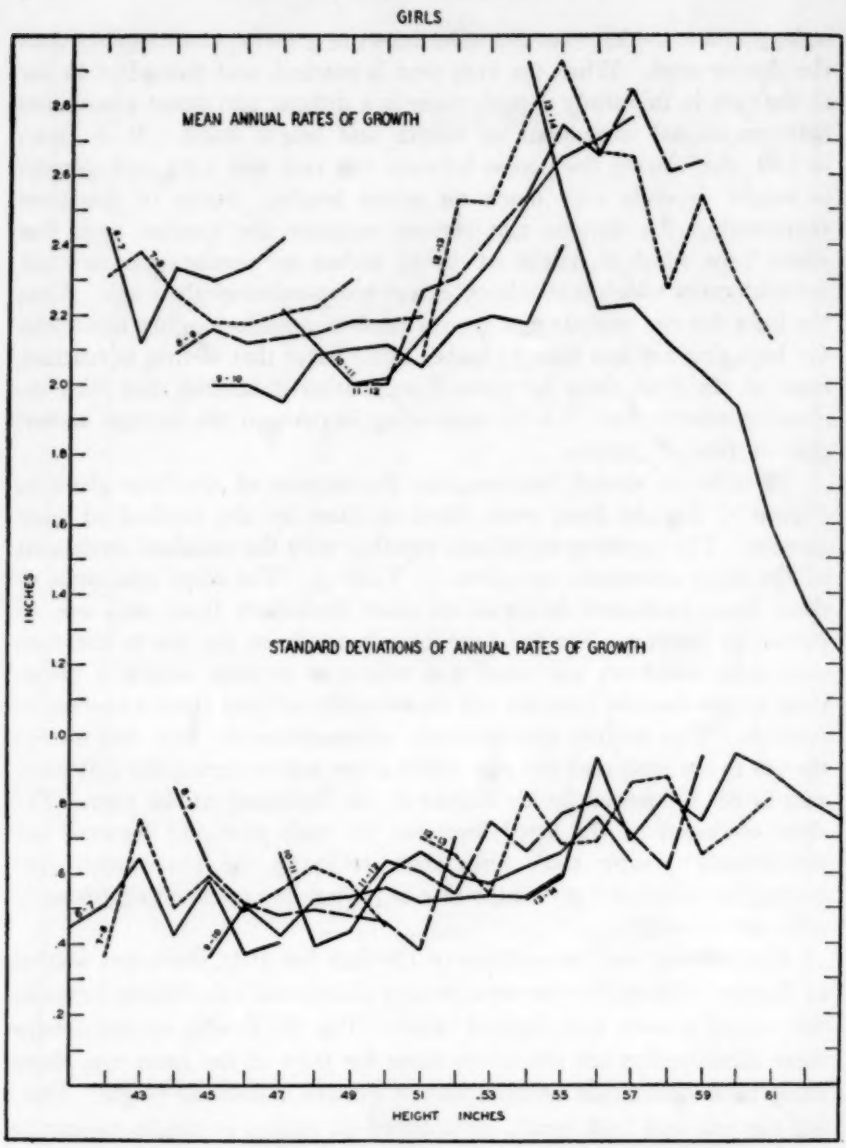

FIG. 2. REGRESSION LINES SHOWING THE MEAN ANNUAL RATES OF GROWTH IN HEIGHT (INCHES PER YEAR) AND STANDARD DEVIATIONS OF ANNUAL RATES OF GROWTH OF ELEMENTARY SCHOOL GIRLS OF SPECIFIED HEIGHT.

The small numbers placed beside the lines indicate the age interval for which the rates apply.

relationship for the 11th to 12th year shows that the rate of growth becomes progressively greater the greater the attained height, except that the rates for the very tall individuals tend to be reduced. A striking relationship between size and rate of growth appears during the 12th and 13th year. In this period girls who are below 55 inches in height grow more *rapidly* the greater their actual height, while girls above that height grow more *slowly* the greater their stature. For the next year, 13 to 14, growth rates progressively decrease with increase in height.

Summarizing the data for girls, it is clear, first, that during the 6th through the 9th year growth depends on age and is little influenced by actual height; second, that after the 10th year the rate of growth depends very largely on height, and third, that critical or turning points in growth occur at heights of approximately 51 inches and at 55-56 inches. Thus, average growth is independent of size before a height of 51 inches is reached, growth increases with actual height between 51 to approximately 55 or 56 inches, and after 57 inches is attained, average growth decreases with increasing height.

TABLE 3

Regression Lines Showing the Relationship Between Average Annual Rates of Growth and Attained Height

In the equations, X_n = height, in inches, at age n; Y_n = average annual rate, inches per year, from age n to n + 1. The numbers in parenthesis are approximate values of the standard deviations of the regression constants.

BOYS	GIRLS
$Y_6 = +1.67 + .016\ (\pm.022)\ X_6$	$Y_6 = +1.17 + .026\ (\pm.018)\ X_6$
$Y_7 = +1.86 + .008\ (\pm.012)\ X_7$	$Y_7 = +2.87 - .014\ (\pm.013)\ X_7$
$Y_8 = +2.30 - .003\ (\pm.009)\ X_8$	$Y_8 = +2.05 + .002\ (\pm.009)\ X_8$
$Y_9 = +2.39 + .008\ (\pm.007)\ Y_9$	$Y_9 = +0.73 + .027\ (\pm.008)\ X_9$
$Y_{10} = +0.48 + .029\ (\pm.007)\ X_{10}$	$Y_{10} = -2.32 - .089\ (\pm.010)\ X_{10}$
$Y_{11} = -0.47 + .045\ (\pm.009)\ X_{11}$	$Y_{11} = -1.78 + .079\ (\pm.011)\ X_{11}$
$Y_{12} = -3.75 + .107\ (\pm.015)\ X_{12}$	*$Y_{12} = -7.02 + .181\ (\pm.019)\ X_{12}$
$Y_{13} = -4.48 + .122\ (\pm.023)\ X_{13}$	†$Y_{12} = +9.33 - .118\ (\pm.015)\ X_{12}$
	$Y_{13} = +11.66 - .165\ (\pm.018)\ X_{13}$

* From 51 to 55 inches.
† From 55 to 61 inches.

In Table 3 are recorded the results of fitting straight lines to the irregular lines shown in Figure 2. For the age group 12 to 13 two lines were fitted, one for heights from 51 to 55 inches, and the other for heights from 55 to 61 inches. Obviously, several of the irregular lines are not well represented by linear equations but the slope constants of the equations, viewed in connection with their standard deviations, indicate in a rough way the statistical significance of the association between height already attained and growth in height during the next year.

The analysis so far made suggests a fundamental characteristic of growth of the maximum linear dimension during the 6th to the 14th year. During the early part of this period, while boys are less than 53 inches in height and girls less than 50-51 inches, average growth is closely associated with age. At this time there is, with increasing age, a gradual diminution in the rate of growth. Children, regardless of their actual height, grow like other children of the same age and sex. When, however, girls approach a stature of 50-51 inches and boys a stature of 53-54 inches, a striking change occurs in the manner of their growth. It may be postulated that, when these critical statures are reached, the lagging growth processes are suddenly stimulated. In girls, the stimulation persists and increases in intensity until a height of 55-56 inches is attained; in boys the stimulating influence progressively increases at least until a height of 60-61 inches is reached. After girls reach a height of 55-56 inches the accelerating influence diminishes, the average gains becoming less with the increase of each inch in stature. And, although available data are lacking, it must be postulated that a maximum rate for boys occurs some time after they become 61 inches tall and that their rates of growth diminish, finally, with increasing stature.

These findings may be regarded as extending in some particulars the usual conception of the well-known "adolescent acceleration" of growth. This acceleration or "spurt" of growth is associated usually with the attainment of specific chronological ages. And, while it is impossible to separate clearly age and attained height, it is apparent from these results that the accelerated phase of growth is synchronized more definitely with actual size than with chronological age.

Information concerning the precise relationship of the adolescent acceleration of growth and the appearance of various characteristics of sexual maturity is not well known. However, the results here shown,

together with those reported by Boas (5), and Ritchey (8), lead to interesting speculations as to relationship between actual stature and sexual development. Both Boas and Ritchey have shown that children who are large for their age "mature" earlier than those who are small. In the light of these findings the hypothesis is suggested that the development of sexual maturity may be associated intimately with the length of the human body. Thus it does not seem unlikely that the appearance of changes characteristic of puberty may show less variation, if measured on the scale of body length than if measured on the scale of chronological age, as is usually done.

The findings reported above are particularly pertinent, also, with respect to recent developments in child hygiene. During the past decade it has been customary to use the average values of the height and weight of school children as standards with which to compare measurements of individual children. If the measurements of an individual are found to deviate considerably from the average of other children of the same age, that individual is believed to be unhealthy. Recently this method of diagnosing ill health or malnutrition has been criticised very sharply and a number of workers have argued that a child's actual size does not indicate the state of his health nearly as well as does his progress or gain in height and weight. From this point of view it is maintained that if a child's gains during a given period of time deviate widely from the average gain made by children of the same age, that child is potentially unwell. At the present time standards showing average annual gains in height and weight for children of different ages are being suggested for general use in school hygiene work. Without going into either the soundness or practical utility of this procedure, it must be noted that no single average gain in height satisfactorily represents growth during any age in the adolescent period. For example, it has been shown (Table 2) that the average yearly gain of girls 51 inches tall at 13 years of age is only slightly over two inches per year, while the average gain of girls 55 inches tall at the same age is nearly three inches per year. Thus any attempt to set up standards with which the growth of individuals is to be compared should take into consideration, during adolescence, the actual height already attained. Until more complete data are available it would seem likely, therefore, that the annual rates shown in the lowest horizontal row of tables 1 and 2 would furnish appropriate averages.

STANDARD DEVIATIONS OF ANNUAL RATES OF GROWTH

A study of the variability of annual gains in height of children of a specified age and height not only provides a measure for the proper interpretation of the mean annual gains but it also furnishes a quantitative measure of the tendency for individuals, who were alike in height, to become unlike after a year of growth. Put in another way, this standard deviation serves as an index of the differentiating or *dispersing effect of growth* and it will be of interest to inquire whether or not the tendency toward dispersion varies with height itself and whether or not it changes with age.

In the lower sections of Figures 1 and 2, lines representing the standard deviations of annual increments for children of different height are shown for each age class. The method of representing the data graphically is similar to that used for the mean annual growth rates shown in the upper sections of the diagrams.

Viewing the trends of the standard deviations for the first five age classes for boys (Figure 1, lower section), it is seen that the variability constants fluctuate somewhat irregularly. The slope of these lines for the separate ages is generally positive and, also, there is a slight tendency for the variabilities of rates of growth to decrease with age. On the whole, however, there is little evidence of an association between the indices of dispersion and either age or actual height, and it may be concluded that during the interval between the 6th to 11th year boys tend to become different with respect to height, after a year of growth, at a relatively uniform rate. During the 11th to 12th year there is a marked increase in the standard deviations, but there is still no conclusive evidence that the taller boys differentiate more rapidly than the shorter ones. However, the line representing the standard deviations for the year of growth from 12 to 13 is inclined sharply from the horizontal position, indicating a direct association between height itself and the tendency toward divergence in height. During the last age for which data are available, the constants of dispersion are large, but the line representing this age is not markedly inclined from the horizontal, again indicating that actual height does not change materially the rate of dispersion.

Turning now to the variability of growth rates for girls, it is seen (Figure 2, lower section) that the lines representing the different ages show considerable irregular fluctuation. During the 6th to 7th, 7th to 8th, 8th to 9th, and 9th to 10th years, these lines are nearly horizontal

and almost superimposed upon each other. There is little association between age or height and variation in rate of growth. In the interval between the 10th and 11th year, and thereafter through the 13th and 14th year, the lines representing the changes in variation of growth are inclined definitely from the horizontal position, although there are, apparently, no great differences in the relative positions of the lines representing the different age classes. It may be concluded, therefore, that variability of growth, or the tendency for a year's growth to make individuals different with respect to height, is, during adolescence, greater for the taller girls than for the shorter ones and that age has little influence on the dispersing effect of growth.

SUMMARY

1. This paper represents the first part of a study of growth by the "individual" or "longitudinal" method. By definition this method involves the use of *seriatim observations of the same individuals* and is thus differentiated from the more usual "average" method, in which growth changes are inferred from observations on different individuals measured at different periods in their growth.

2. The material, which was collected by the U. S. Public Health Service between 1922 and 1928 at Hagerstown, Maryland, deals with the growth in height of elementary school children. The data used are the annual measurements of height, on the average five measurements per child, of approximately 2,400 white native-born children. The analysis consists of the calculation of the average and standard deviation of annual gain in height, in inches per year, of children of given age and sex and *of the same height at the beginning of the year.* The principal results of the study are reviewed briefly as follows:

(a) For boys, mean annual rates of growth in height decrease regularly from the 6th through the 10th year of age. During this period growth in height is largely independent of height itself. The adolescent acceleration in growth begins quite abruptly, regardless of age, when boys reach a height of 52-53 inches and continues until a height of at least 60-61 inches is reached. During this accelerated phase of growth there is a marked positive correlation between the average rate of growth and height itself; that is, the greater the stature, between 55 and 61 inches, the more rapid the rate of growth.

(b) For girls, average annual rates of growth in height decrease regularly from the 6th through the 9th year, and are independent of attained height. The adolescent acceleration for this sex begins when a height of 50-51 inches is reached and continues until a height of 55-56 inches is reached. After the latter stature is attained there is a marked decrease in growth rates. Throughout the adolescent period, irrespective of age, there is a definite association between average growth in height and height itself.

(c) Viewing as a whole the results summarized in (a) and (b) above, it is concluded that the adolescent acceleration and deceleration of growth in height is synchronized closely with actual height and that both the acceleration and the deceleration tend to occur more particularly at certain points on the scale of height than on the scale of chronological age.

(d) Study of the variability of annual gains in height, in age and sex and height-specific classes, shows that during the adolescent accelerated phase of growth there is a slight positive association, more marked for girls than boys, between the height of a child and the variability of his gain in height during the following year.

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VITAL DATA ON THE POPULATION OF THE SEMINOLE INDIANS OF FLORIDA AND OKLAHOMA

BY WILTON MARION KROGMAN

Anatomical Laboratory, Western Reserve University, Cleveland, Ohio

IN THE summer of 1932 the writer was privileged to lead the field party in physical anthropology of the Laboratory of Anthropology, Santa Fe, New Mexico. The Seminole Indians of Oklahoma were chosen as the subjects of the field study. In the course of the study genealogies of 2056 Seminoles and Seminole-breeds were secured. These have been analyzed in detail as presented in this paper. In addition a historical study of population has been undertaken, based mainly on Swanton (9), MacCauley (7), and Nash (8). We shall, therefore, present the material in two main sections.

POPULATION

A discussion of the population of the Seminole is a necessary prelude to any analysis of vital statistics. We shall later discuss the problem of mortality among the Oklahoma Seminoles, interpreting the data in the light of the fluctuation in total number and racial make-up of the group.

Swanton's (9) work on the Creek Indians and their neighbors contains practically all of the data available on the numbers of the early Florida Seminoles. The total population of the Lower Towns is given (p. 435):

Spanish census of 1738 (men)	757
French census of 1750 (men)	398
Census of 1760 (men)	1,030
Census of 1761 (hunters)	770
Taitt's census of 1772 (gunmen)	470
Marbury 1792 (men)	1,105
Hawkins 1799 (men)	430
U. S. Census 1832 (souls)[1]	7,408

[1] Giddings (4, p. 70) says that in 1822 a Sub-Agent for the Florida Indians estimated their number as 5,000. In 1823 the Indians themselves returned a count

In accordance with general usage (especially Bartram) the Lower Towns are the true or older Seminole. The contact of this group with the Apalachee and Apalachicola resulted in a partial assimilation of these two tribes[2] into the Seminole.[3] It is thus important to remember that the earliest figures for total male population include captured remnants of the earliest Floridian Indians.

The figures above given are, except for the 1832 census, for male population only. It is difficult to estimate total population, but Swanton (9, p. 433) comments on a Yuchi male population in 1792 of 300 men as indicative of a total population of over 1,000. It would seem, therefore, that the numbers of "men," "hunters," or "gunmen," form approximately one-third, or a little less, of the total population, embracing women and children as well.

Bartram (2, p. 209) said of the Seminoles: "All of them, I suppose, would not be sufficient to people one of the towns of the Muscogulge; for instance, the Uches, on the main branch of the Apalachucla River, which alone contains near two thousand inhabitants."[4] Swanton (9, p. 440) observes of this: "He probably much exaggerated the number of Yuchi, but there is reason to believe that his estimate for the Seminole was not far wrong. Upon the whole it appears likely that the older Seminole with whom Bartram had to deal, those living in the Peninsula before the Creek-American War, constituted about one-third of the total number after the refugees from the Upper Creeks had been incorporated, and this would make them 1,500 or a little more."

Bell, agent for the Indians in Florida, listed in 1821 some 34 villages of which 16 belonged to the old Seminoles, and 15 to the immigrant Creeks (or new "Seminoles"), the remaining three to Negroes settled among the Indians. The one to two ratio of old to new Seminoles is not retained in the number of villages, but Swanton (9, p. 406) observes that the towns of the newcomers were more populous, so that actually, in bulk of numbers the proportion of refugee Creeks to old Seminoles was present.

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of 4,883, exclusive of Negroes. Penieres, U. S. Agent, estimated 1,200 warriors and a total population of 3,000 in 1821. Swanton (9, p. 440) accepts 4,000 as a general average. The census of 1832 probably included many Creeks.

[2] In 1638 there were 16,000 Apalachees, and in 1676 only 5,000. In 1703-04 came the disastrous Creek invasion (Swanton, 9, p. 121).

[3] "It is to the Seminole that most of the scattered bands of the Apalachicola went" (*Ibid.*, p. 134). In 1832 some 239 Apalachicola Indians and seven slaves were removed to Okmulgee, Oklahoma (p. 134).

[4] Bartram (2, p. 386) says of the Yuchi that they had 500 warriors and a population of 1,000-1,500. In 1832 two Yuchi settlements had a total population of 1,139 (Swanton, 9, p. 433).

TABLE 1

Seminole Population From 1834-1928
Based on Swanton (7) and U. S. Indian Office Returns

YEAR	FLORIDA	OKLAHOMA	FREEDMEN	TOTAL	YEAR	FLORIDA	OKLAHOMA	FREEDMEN	TOTAL
U. S.					1868	...	1,950	...	1,950
1836	3,765	....	...	3,765	1869-70 ..	...	2,136	...	2,136
1837	5,072	....	...	5,072	1871	...	2,300	...	2,300
1838	3,565	....	...	3,565	1872	...	2,398	...	2,398
1841	3,765	....	...	3,765	1873-5 ..	...	2,438	...	2,438
1842	....	3,612	...	3,612	1876	...	2,443	100	2,543
1843	....	3,824	...	3,824	1877-8 ..	...	2,223	200	2,423
1844	....	3,136	...	3,136	1879	...	2,560	...	2,560
					1880-1 ..	...	2,667	...	2,667
School-					1882	...	2,700	...	2,700
craft					1883-7 ..	...	3,000	...	3,000
1846	...	3,250	...	3,250	1888	...	3,050	...	3,050
1847	370	1,500	...	1,870	1889-91 ..	...	2,600	...	2,600
1850	348	1,500	...	1,848	1892	...	3,000	...	3,000
					1893-4 ..	450	3,000	...	3,450
U. S.					1895	565	2,900	...	3,465
1851	...	2,500	...	2,500	1896	565	2,000	...	2,565
1853	500	2,500	...	3,000	1897	565	2,900	...	3,465
1855	500	2,500	...	3,000	1898-9 ..	575	2,900	...	3,475
					1900	...	3,000	575	3,575
School-					1901	358	2,757	...	3,115
craft					1902-4 ..	358	2,750	...	3,108
1855	...	2,500	...	2,500	1905	358	2,099	950	3,407
1857	...	2,500	...	2,500	1906	358	2,132	979	3,469
					1907	358	2,138	986	3,482
U. S.					1908-9 ..	358	1,399 739 *	986	3,482
1857	...	1,907	...	1,907					
					1910	358	2,137	986	3,481
School-					1911-2 ..	446	2,137	986	3,569
craft					1913	600	2,133	986	3,719
1857	...	1,870	...	1,870	1914	562	2,133	986	3,681
					1915	587	1,254 887 †	986	3,705
U. S.									
1858	...	2,060	...	2,060	1916	574	2,141	986	3,701
1859	...	2,253	...	2,253	1917	586	2,141	986	3,713
1861	...	2,267	...	2,267	1918	585	2,141	986	3,712
1865-6 ..	...	2,000	...	2,000	1919-24 ..	573	2,141	986	3,700
1867	...	2,236	...	2,236	1924-28 ..	506	2,141	986	3,633

* Lower number equals mixed bloods.
† Mixed blood: ½ plus 478; ½ minus 409.

The conclusion is warranted, therefore, that the number of Seminoles prior to about 1800 was approximately 1,500 (old or true Seminoles). The total number in 1832, the date of removal to the West, was about 4,500, a figure which includes both the old and new (Creek refugee) Seminoles.

Not all of the Seminoles were removed to the West, for some of them fled to the fastness of the Everglades.

The first attempt to enumerate the Florida Seminoles (hereinafter used in the modern sense) was that of MacCauley (7, p. 484) who in 1880 listed 208 individuals. Swanton (9, p. 441) quotes the Indian Office as estimating 450 in 1893-4; 565 in 1895-7; 575 in 1898-1900; 358 in 1902 and following years; 446 in 1911; 600 in 1913; and 562 in 1914 (See also the accompanying Table 1). Hrdlička (6, p. 65) stated that in 1922 there were between five and six hundred. Nash (8, p. 23) lists the Census of 1930 as totaling 578, including 10 mixed bloods.

If we consult the general trend it is probably correct to assume a present-day population of Florida Seminoles as about 500. Of them Swanton (9, p. 441) states: "There is known to be a considerable admixture of Negro blood . . . but the amount of White blood is practically negligible."

The number of Seminoles removed to Indian Territory (now Oklahoma) is not absolutely certain. Giddings (4, pp. 254-5) states that by 1840 upwards of 2,000 Indians and Exiles (Negroes) were living in Cherokee lands, and mentions that in 1841 an additional 250 Seminoles, plus 14 Mickasukies, left Florida for the West. Swanton (9, pp. 440-1) offers the following populations, including Freedmen,[5] for the Oklahoma Seminoles: 3,765 in 1836; 5,400 in 1837; 3,500 in 1838-43; 2,500-3,000 in 1844-56; 1,907, by actual census, in 1857;[6] 2,500 in 1872; and 2,500-3,000 in the present time (See also accompanying Table 1[7]).

The Bureau of American Ethnology, (BAE II, p. 501) stated the Seminole population in Oklahoma to be, in 1907, a total of 2,138, "largely mixed with Negro blood," in addition to 986 Freedmen. Swanton offers for 1908 a total of 1,399 full-bloods and 739 mixed bloods, exclusive of the Freedmen. In 1910 there were 1,503 Oklahoma Seminoles (pure bloods?).

Swanton concludes "that the actual full bloods, could the truth be known, would be found to number a mere handful" (9, p. 441). And again:

"The number of Creek and Seminole full bloods has also declined progressively. In 1908 rather more than half of both were returned as full-blood Indians, but I am confident that the actual number is very much smaller. . . . The Indian blood . . . appears to be spreading out continually, but it is spreading over a body of White and Negro blood ever greater in amount, while the Indian blood becomes less and less." (p. 456)

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[5] Freedmen were found, in 1905, to comprise about one-third of the total population.

[6] This must exclude Freedmen.

[7] In 1850-1 ca. 300 Freedmen and half-breeds fled to Mexico (Giddings, 4, p. 306; BAE II, p. 501).

With this statement I am entirely in agreement, except that I am inclined to think there may be more Indian full-bloods than Swanton intimates.[8] By this I mean that though there may be very few full-blood Seminoles and full-blood Creeks, there are quite a number who are full-blood Creek plus Seminole. I must, of course, reserve the general fact that both groups are prone to the inclusion of White and Negro blood from distant sources. In the treatment of data I designated as "full-blood" individuals in whose genealogy no alien blood had entered for three or four generations. But Indian blood is on the wane. It is but a matter of time before the White tide flows in all Indian veins.

We may offer, by way of summary of the population question, the averages presented by Swanton[9] (9, p. 456):

1780	1,500	Florida
1821	4,750	Florida
1857	2,500	Oklahoma
1892	3,500	Oklahoma
1906 to present	2,500	Oklahoma

As a corollary of the population problem we are interested in the distribution of Seminoles in villages, for these towns or villages later on gave rise to "bands," which became distinct and important political entities.

Bartram (2, p. 462) lists the Seminole towns as follows (1778):

Suola-nocha
Cuscowilla or Aluchua
Talahasochte
Caloosahatche
..... Great Island
..... Great hammock
..... Capon
..... St. Mark's
..... Forks
} Trader's names.

Hawkins enumerates the following: O-co-nee, Sau-woog-e-lo, Eu-fau-lau, Tummault-lau, Pa-la-chooc-le, and Hitch-e-tee. Of these Eu-fau-lau, only, belonged to the Muskogee proper (Swanton, 9, p. 400).

[8] The Office of Indian Affairs makes no pretense of distinguishing degree of blood (Part 4 of Senate hearing 1929).

[9] No attempt is made at assessment of blood. Freedmen included in Oklahoma figures. I would place the present number nearer 3,000.

Penieres, in 1821, divides the Creeks into Mekasousky, Souhane, Moskoky, Santa-Fe, Red-stick, and Echitos. The Seminoles are divided into the Larchivue, Olkevuaha, Chockechiatte, Pyakle-kaha, Tale-houyana, and Topkelake (Swanton, 9, p. 404; Hrdlička, 6, p. 61-5). Bell, in 1821 listed 16 old Seminole towns, 15 new (refugee Creek) Seminole towns, and 3 Negro towns. Morse, at about the same time listed 21 towns,[10] with a total population of 6,385, of which 1,400 were Mikasukis (Swanton 9, pp. 408-9).

When the Seminoles first arrived in Oklahoma they settled in 27 towns or bands (1845) which a year later were reduced to 26. The number was gradually reduced until in 1912 there remained only six towns or neighborhoods which retained their square grounds, the symbol of group unity. One of these, the Mikosaki ground, was located near Seminole, Oklahoma.

In 1932 the Seminole Council was re-organized. There were fourteen bands, two of which were Freedmen bands (13 and 14).

1. William Cully Band
2. Tom Palmer Band
3. Yaha Harjo Band
4. Kin-ke-he Band
5. George Jones Band
6. William Conner Band
7. Okoske Harjo Band
8. Echo Emartha Band
9. John Letka Band
10. Thomas Little Band
11. Nulcup Harjo Band
12. Tom S. McGiesey Band
13. Caesar Brunner Band
14. Dosar Barkos Band

These bands have quite apparently lost any vestige of ancient tribal organization. They are really no more than neighborhood aggregations under a locally esteemed "Band Chief," elected by the members of the band by vote. According to informants each band theoretically still has its own square ground, but we heard of only four such grounds. The "Church" groups do not have them; it is only the "Stomp-dance" bands that retain the old band meeting place. Up to within several years each square-ground had 14 encampments around it, one for each band. Now this, too, has gone, and only the old-timers and their adherents cling to the square-ground as a symbol of group consciousness. It is interesting to observe, however, that the Church Group have transferred the pattern to their camp-meetings. Each participating Band has its own special encampment on the outskirts of the ground constituting the central religious meeting place.

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[10] "This appears to include merely the uppermost Seminole towns, along with some which properly belong to the Lower Creeks" (9, p. 409).

MORTALITY

In round numbers the total population of the Seminoles in Florida has decreased from an average 3500-4000 prior to the westward removal, to an average 400-500 since that time, i.e. from 1840. The total population of the Seminoles in Oklahoma has ranged from an early 3500, on the average (up to about 1850), to a very consistent average of about 3000, including the Freedmen, who number about 1000. For the purposes of discussion, therefore, we shall accept the round number averages of 500 for the present day Florida Seminoles, and 2000 for the Oklahoma Seminoles, excluding all Freedmen in both groups.

From 1898 to 1906 the United States enrolled all members of the Five Civilized Tribes[11] for the purpose of extinguishing tribal land titles and re-allotting such land in severalty. This enrollment—in reality a detailed census of the people—gave the age and, as far as possible, the blood kinship of each individual. Since the closing of the rolls Judge J. B. Campbell of Holdenville, Oklahoma, has compiled an "Index" of the Seminole rolls, arranging the data by census cards, giving name, age, and kinship wherever possible. This Index was made available to me through the courtesy of Mr. Spencer Norvell, Mr. J. Read Moore, and Judge M. S. Robertson, of Wewoka, Oklahoma. In addition, through the courtesy of Mr. Allen Crain of Sasakwa, Oklahoma, I have had access to duplicates of the original census cards, belonging to the Seminole Nation, in order to verify certain discrepancies and to trace in more detail certain kinships. The Index was published in 1925 and gave all deaths of enrolled individuals officially recorded to that date.

The Index was a constant companion in all our field work. Each adult was questioned regarding the accuracy of his or her enrollment, and requested to give all pertinent familial data subsequent to the closing of the rolls. Most important of all, information was sought concerning the age at death, or year of death, so that death-age could be computed from the rolls.

As a result there is available for the present study information on the age of 2056 individuals, for the most part Seminoles, but including also some Creek, White, and a few Negro mixtures. There are also data on the age at death of 463 individuals, presumably representing the

[11] Creeks, Cherokees, Choctaws, Chickasaws, and Seminoles.

mortality occurring since 1898 and 1907, the dates of the original enrollment and the "new-born" enrollment respectively. The mortality figures are only approximate, for in many instances the fate of this or that individual was unknown even to his kin. There is also a pronounced tendency to forget the birth and early death of children [12] in a long series of brothers and sisters. Among the earlier Indians (early part of this century) birth was such an annual or bi-annual affair that one or two missing in a mental recount was not cause for perturbation. The younger generation have fewer children and they are getting relatively good care, especially in infancy. There are still, however, a goodly half of the population to whom pre-natal and post-natal hygiene are unknown. These factors must, therefore, be taken into consideration when evaluating the data to be presented.

The total population of the Florida Seminoles was stated by MacCauley (7) in 1880 to be 208. This is certainly at a variance with the average population of 500 generally accepted. It is probable that he did not get to all the camps, many of them "lost" in the Everglades. From the figures given by him I have calculated Table 2.

TABLE 2

Age and Sex Distribution of Florida Seminoles, 1880

	MALES		FEMALES		TOTAL	
	No.	%	No.	%	No.	%
Below 5 years	12	10.7	13	13.5	25	12.0
5 to 10 years	9	8.0	10	10.4	19	9.1
10 to 15 years	22	19.6	8	8.3	30	14.4
15 to 20 years	23	20.5	10	10.4	33	15.9
20 to 60 years	38	33.9	46	47.9	84	40.4
Over 60 years	8	7.2	9	9.4	17	8.2
	112		96		208	

MacCauley observes of the foregoing:

In this table it will be noticed that the total population consists of 112 males and 96 females, an excess of males over females of 16. . . . It will also be

[12] Indeed, many of these were never reported to the Superintendent of the Five Civilized Tribes of Muskogee.

observed that between twenty and sixty years of age, or the ordinary range of married life, there are 38 men and 46 women; or if the women above fifteen years of age are included as wives for the men over twenty years of age, there are 38 men and 56 women. . . . Notice, however, the manner in which the children of these people are separated in sex. At present there are, under twenty years of age, 66 boys, and under fifteen years of age, but 31 girls; or setting aside the 12 boys who are under five years of age, there are as future possible husbands and wives, 54 boys between five and twenty years of age, and 31 girls under fifteen years of age—an excess of 23 boys. . . . There are now but 17 persons of the tribe over sixty years of age, and no unusual mortality has occurred, certainly among the adults, during the last twenty years. Of the 84 persons between twenty and sixty years of age, the larger number are less than forty years old; and under twenty years of age there are 107 persons, or more than half the whole population. The population tables of the Florida Indians present, therefore, some facts upon which it may be interesting to speculate.

The disparity between the sexes which so badly puzzles MacCauley is, I think, intrinsic evidence of the probability that he has not tabulated the entire population. Later available figures substantiate neither the numbers nor the sex ratio, though the general age grouping is not greatly changed.

Nash (8) offers data from the 1930 Census, for which I have calculated the averages given in Table 3.

TABLE 3

Age and Sex Distribution, Florida Seminoles, 1930

	MALE		FEMALE		TOTAL	
	No.	%	No.	%	No.	%
Under 1 year	4	1.4	5	1.7	9	1.6
1 to 3 years	18	6.2	13	4.5	31	5.4
4 to 9 years	37	12.0	38	13.2	75	13.0
10 to 19 years	62	21.4	87	30.2	149	25.8
20 to 29 years	50	17.2	51	17.7	101	17.4
30 to 39 years	50	17.2	50	17.4	100	17.3
40 to 49 years	25	8.6	19	6.6	44	7.6
50 to 59 years	22	7.6	13	4.5	35	6.0
60 to 69 years	14	4.8	6	2.1	20	3.5
70 to 79 years	1	0.3	5	1.7	6	1.0
80 to 89 years	7	2.4	0	...	7	1.2
Over 90 years	0	...	1	.3	1	.2
	290		288		578	

The foregoing figures include 10 "mixed bloods" and 568 "full-bloods."

In the light of these data MacCauley's observations do not hold, or, the only other alternative, there has been a relatively tremendous increase in numbers in the past 50 years.

MacCauley stated that "more than half the whole population [was] under twenty" (his actual figures say 58.8 per cent). According to Nash's estimates 41.8 per cent are 19 or under, 59.0 per cent are 29 or under, and 76.2 per cent are 39 or under.

The fact remains that the great bulk of the population, about 75 per cent, are early middle-age or less. If this can be construed as evidence, by inference, of an early mortality it is extremely significant.

TABLE 4

Age and Sex Distribution of Oklahoma Seminoles 1898-1906

AGE	FREQUENCY			PERCENT OF TOTAL		
	M.	F.	Both	M.	F.	Both
0- 1	81	116	197	7.81	11.37	9.58
1- 4	76	88	164	7.33	8.62	7.97
0- 4	157	204	361	15.15	20.	17.55
5- 9	141	168	309	13.61	16.47	15.02
10-14	124	101	225	11.96	9.90	10.94
15-19	137	107	244	13.22	10.49	11.86
20-24	105	108	213	10.13	10.58	10.35
25-29	109	76	185	10.52	7.45	8.99
30-34	52	48	100	5.01	4.70	4.86
35-39	43	47	90	4.15	4.60	4.37
40-44	40	53	93	3.86	5.19	4.52
45-49	52	33	85	5.01	3.23	4.13
50-54	14	21	35	1.35	2.05	1.70
55-59	17	17	34	1.64	1.66	1.65
60-64	20	14	34	1.93	1.37	1.65
65-69	13	7	20	1.25	.68	.97
70-74	5	4	14	.48	.89	.68
75-79	3	4	7	.29	.39	.34
80-84	1	3	4	.09	.29	.19
85-89	2	..	2	.19	...	.097
90-94	1	..	1	.09	...	.048
	1036	1020	2056			

In Table 4 I have tabulated the age and sex distribution of the 2056 Oklahoma Seminoles upon which I secured age information. The data are grouped into the customary five-year periods. If this table be analyzed the following grouping occurs:

Group	*0-19*	*0-29*	*0-39*
Male	53.94%	74.59%	83.75%
Female	56.86%	74.89%	84.19%
Total	55.37%	74.71%	83.94%

TABLE 5

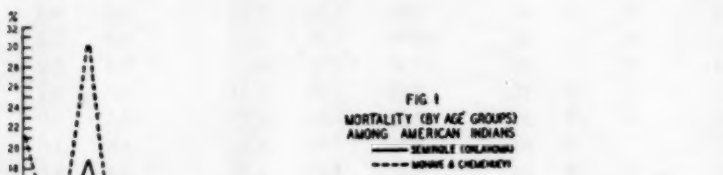
Mortality of the Oklahoma Seminoles, 1898-1932
Compared With the Mohave and Chemehuevi, 1910-1930

AGE	SEMINOLE						MOHAVE AND CHEMEHUEVI		
	Frequency			Percentage			Percentage		
	M.	F.	Both	M.	F.	Both	M.	F.	Both
0- 1.....	19	22	41	7.94	9.82	8.85	20.1	22.6	21.3
1- 4.....	25	21	46	10.46	9.37	9.93	10.1	7.7	8.9
0- 4.....	44	43	87	18.41	19.19	18.79	30.2	30.3	30.2
5- 9.....	20	22	42	8.36	9.82	9.07	2.4	3.6	3.0
10-14.....	18	16	34	7.53	7.14	7.34	2.9	2.4	2.6
15-19.....	24	19	43	10.00	8.48	9.28	6.5	8.3	7.4
20-24.....	32	27	59	13.38	12.05	12.74	7.1	5.9	6.5
25-29.....	18	17	35	7.53	7.58	7.55	4.7	4.2	4.5
30-34.....	18	18	36	7.53	8.03	7.77	3.5	3.6	3.5
35-39.....	4	6	10	1.67	2.67	2.15	1.8	4.8	3.3
40-44.....	13	10	23	5.43	4.46	4.96	2.4	2.9	2.6
45-49.....	15	13	28	6.27	5.80	6.04	4.7	1.8	3.3
50-54.....	7	8	15	2.92	3.57	3.23	7.1	4.8	6.0
55-59.....	5	5	10	2.09	2.23	2.15	4.7	3.0	3.9
60-64.....	8	7	15	3.34	3.12	2.23	7.1	5.9	6.5
65-69.....	6	6	12	2.51	2.67	2.59	5.9	5.9	5.9
70-74.....	1	2	3	0.04	0.09	0.06	3.0	2.4	2.7
75-79.....	2	2	4	0.08	0.09	0.09	2.4	3.6	3.0
80-84.....	1	3	4	0.04	0.13	0.09	2.4	4.2	3.3
85-89.....	2	..	2	0.08	...	0.04	0.6	1.2	0.9
90-94.....	1	..	1	0.04	...	0.02	0.6	1.2	0.9
	239	224	463						

As is shown by the total number of males and females there is no pronounced sex difference: 50.4 per cent (1036) males, 49.6 per cent (1020) females. This general proportion is not maintained in the earlier years, especially below 19, for there are more younger females than there are younger males. The ultimate achievement of the observed total sex ratio is due to the fact that there are more males than females in the older age groups.

The important fact, however, is the relatively great preponderance of young people in the total population: 55.37 per cent below 19 years of age, 74.71 per cent below 29, and 83.94 per cent below 39—figures in substantial agreement with those for the age-groups of the Florida Seminoles. The Oklahoma Seminoles, as for the census of 1898 and 1906, are essentially a population among whom old age, i.e. used in the sense of past late middle age, is relatively infrequent.

This is graphically depicted in Table 5 in which are presented the deaths of the Oklahoma Seminoles, grouped in five-year age intervals. The data are grouped numerically and by percentage for each sex and for total number in each age-group. In addition there is presented the percentage, similarly grouped, for the full-blood Mohave and Chemehuevi Indians studied by Clements (3). The curve for the percentage in the totals of each age-group, and for the several tribes, is presented in Figure 1.



There are two rather marked differences between the two sets of data: the low infant mortality and the greater death frequency in post-adolescent years among the Seminoles; and the relative peak of old age death among the Mohave and Chemehuevi.[13]

[13] Though compared to the Whites the peak is practically non-existent.

As mentioned earlier the figures for total percentage of infant mortality, i.e. between birth and one year, among Oklahoma Seminoles, are probably incomplete. This is apparent when the percentage is compared with the percentages of totals for other groups (taken from Clements).

Age	*Seminole*	*Mohave and Chemehuevi*	*Whites*	*Indians*	*Negroes*
0-1	8.85	21.30	16.10	21.10	16.70
1-4	9.93	7.70	5.60	13.60	6.30
0-4	18.79	30.30	21.70	34.70	23.00

TABLE 6

Death-rate of the Oklahoma Seminoles, 1898-1932

AGE	MALES			FEMALES			BOTH		
	Living	Dead	%	Living	Dead	%	Living	Dead	%
0- 1...	81	19	23.45	116	22	18.96	197	41	20.81
1- 4...	76	25	32.89	88	21	23.86	164	46	28.04
0- 4...	157	44	28.02	204	43	21.07	361	87	24.09
5- 9...	141	20	14.18	168	22	13.09	309	42	13.59
10-14...	124	18	14.51	101	16	15.84	225	34	15.11
15-19...	137	24	17.51	107	19	17.75	244	43	17.62
20-24...	105	32	30.47	108	27	25.00	213	59	27.69
25-29...	109	18	16.51	76	17	22.36	185	35	18.91
30-34...	52	18	34.61	48	18	37.50	100	36	36.00
35-39...	43	4	9.30	47	6	12.76	90	10	11.11
40-44...	40	13	32.50	53	10	18.86	93	23	24.73
45-49...	52	15	28.74	33	13	39.39	85	28	32.94
50-54...	14	7	50.	21	8	38.09	35	15	42.80
55-59...	17	5	29.41	17	5	29.41	34	10	29.42
60-64...	20	8	40.	14	7	50.00	34	15	44.11
65-69...	13	6	46.15	7	6	85.71	20	12	60.
70-74...	5	1	20.	9	2	22.22	14	3	21.42
75-79...	3	2	66.66	4	2	50.00	7	4	57.14
80-84...	1	1	100.	3	3	100.	4	4	100.
85-89...	2	2	100.	..	..	....	2	2	100.
90-95...	1	1	100.	..	..	....	1	1	100.
	1036	239		1020	224		2056	463	

The frequency of deaths during post-adolescence and early maturity is even more marked among the Seminole than among the Mohave and Chemehuevi. As Clements points out this is typical of the Indian as a race, for the Whites have a late middle-age and old-age peak while the Negroes have a middle-age peak. Among the Seminoles the post-adolescent peak is certainly due to pulmonary disturbances.

In Table 6 the death-rate has been presented, in terms of the total number living and dying in the several age-groups. This table again suffers from inadequacy of information. But, in general, it substantiates the statements already made concerning the frequency of death. If the percentages for the rates be converted into number per 1000 of the population, the rate 208.1 for infants, 0-1, falls rather close to that stated by Aberle (1) for the Pueblo children, 246.7.

The data on the length of life and mortality among the Oklahoma Seminoles are graphically summarized in Table 7.

TABLE 7

Length of Life and Mortality of Oklahoma Seminoles, 1898-1932

AGE	AGE DISTRIBUTION BOTH SEXES		DEATH DISTRIBUTION BOTH SEXES		MORTALITY RATE BOTH SEXES
	No.	%	No.	%	%
0- 1—Infancy	197	9.58	41	8.85	20.81
1- 9—Childhood	473	23.00	88	19.00	18.60
10-19—Adolescence	469	22.81	77	16.63	16.41
20-39—Early Adult	588	28.59	140	30.23	23.80
40-59—Middle Age	247	12.01	76	16.41	30.76
60-79—Old Age	75	3.64	34	7.34	45.33
80+—Senility	7	0.34	7	1.51	100.00
Birth through adolescence	1139	55.39	206	44.49	18.08
Birth through early adult	1727	83.99	346	74.73	20.03
Birth through old age	2049	99.65	456	98.45	22.25

We may conclude as follows:

(1) Infant mortality among the Seminoles of Oklahoma is not as high as stated by Clements for the Mohave and Chemehuevi. But since the data are admittedly inadequate it is probable that the mor-

tality is much the same, for the death-rate per thousand is not so markedly different.

(2) There is a pronounced peak of death, among the Oklahoma Seminoles, occurring early in the third decade. There is no old age peak.

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A BIOMETRIC STUDY OF THE ENDOCRINE ORGANS IN RELATION TO MENTAL DISEASE. PART I[1]

BY RAYMOND PEARL, MARJORIE GOOCH AND WALTER FREEMAN

THE PROBLEM

THE problem with which the present paper is concerned is the determination, by appropriate biometric methods, of the differences between four broad groups of psychiatric patients in respect of the average weights of their endocrine organs, and in respect of the individual variation and correlations of these weights. Modern psychiatry conveniently divides mentally diseased persons into four broad groups, on the basis of the behavioristic symptoms and manifestations of their disease, as follows: Cycloids, Paranoids, Schizoids, and Epileptoids. Unfortunately these diagnostic categories are not wholly mutually exclusive. But for the purposes of the present analysis each individual is put into one or another of the categories according to the preponderance of clinical evidence.[2] Sub-

[1] From the Department of Biology of the School of Hygiene and Public Health of the Johns Hopkins University. Two of the authors [R. P. and M. G.] are solely responsible for the analysis and discussion of the data in this paper, and for its writing. The weights and measures were taken by the third author [W. F.], in the course of routine post-mortem examinations, made in the Blackburn Laboratory of St. Elizabeth's Hospital, of persons dying in that institution, where for some years he was Pathologist.

We are greatly indebted to the Josiah Macy, Jr. Foundation for a grant to the Department of Biology, to aid in the carrying out of this work.

Owing to the length of this paper it is unfortunately necessary to publish it in two parts. Part II will appear in the next number of HUMAN BIOLOGY, and will deal with the parathyroids; hypophysis; gonads; epiphysis; thymus; endocrine inter-correlations; endocrine pattern of the insane; and summary and discussion.

[2] The disposition of each case here included, relative to psychiatric diagnosis, was checked and finally determined by Dr. Nolan D. C. Lewis, of St. Elizabeth's Hospital.

stantially all individuals coming to autopsy during the period covered by the investigation are covered in the records. The material therefore includes some paretics, arteriosclerotics, seniles, and traumatic cases, as well as the so-called pure psychiatric types. But all are classified upon an individual behavioristic basis, regardless of the etiology of the mental disease.

What then are the quantitative endocrine patterns for these four groups?

MATERIAL AND METHODS

The total material available comprises 1337 individuals. These are divided by race (color) and sex as follows:

	Males	*Females*	*Totals*
White	571	235	806
Negro	320	211	531
Totals	891	446	1337

But among these 1337 patients 30 were not assigned to a definite psychiatric group. So then we are left with the following race and sex groupings of the material actually used in this study.

	Males	*Females*	*Totals*
White	564	228	792
Negro	307	208	515
Totals	871	436	1307

It thus appears that 60.6 per cent of the patients here used were whites, and 39.4 per cent Negroes. Of the whites, 71.2 per cent were males, and 28.8 per cent were females. The corresponding figures for the Negroes are 59.6 per cent males and 40.4 per cent females. The difference in the sex distribution of the two racial groups is mainly due to the fact that St. Elizabeth's Hospital fulfills two functions—one as the principal mental disease hospital for the armed forces of the United States; the other as the mental disease hospital for the civilian population of the District of Columbia. The Hospital's female population and the major portion of its colored male population come largely through the latter connection, while its white male population is a composite from both sources.

The methods used in making the autopsies and collecting the data have been sufficiently described by Freeman,[3] and therefore need not be repeated here.

[3] Freeman, W. The weight of the endocrine glands. Biometrical studies in psychiatry, No. 8. HUMAN BIOLOGY, Vol. 6, pp. 489-523, 1934.

The material has certain serious limitations, that should be kept clearly in mind throughout. These are, first, that it relates wholly to a mentally diseased population. Every person included had, and died with if not of, some mental disease. There is available no properly comparable sample from a normal population for comparison. Nor have we any justly comparable sample, that, if not "normal" in the sense of "without evident pathology of any sort," can be put into the category alternative to a mentally diseased one. That is to say the present data can be compared with similar data for persons "not mentally diseased" only by culling very heterogeneous materials from the literature, mostly European or Asiatic. This is a serious defect when the attempt is made to reach a sound, accurate, quantitative description of the endocrine pattern specifically associated with particular types of mental disease. It means that at present, and until there has been slowly built up a sound and considerable body of general human organ-weight data, any conclusions regarding sub-classes relative to general pathology, race, etc., such as we are here dealing with, must be extremely cautious and tentative.

In the second place it must be remembered that we are dealing with hospital autopsy records, where all the individuals died of something or other, many of which lethal agents undoubtedly altered in their progress the biologically normal weight relations of the parts. But in what manner we do not know, and have no way of finding out from data of the present type. For example, the weight pattern of the endocrine organs of a cycloid patient may have been quite different three or four years before he died and while he was enjoying good health (except for his mental difficulties) from what they were found to be at death. Again, as every anthropologist knows, the length of the dead cadaver is quite a different thing from the stature measured on the living. And the same applies also to body weight.

These points are not brought out as a counsel of despair, but merely to bring clearly home to the reader the great logical difficulties that inhere in any attempt to deal effectively with broad biological problems upon the basis of human post-mortem material. If a corps of pathologists could be empowered to kill off and immediately autopsy, with gross and microscopic study, ten to twenty thousand normal healthy human beings of assorted ages, who had been previously thoroughly studied by a corps of physical anthropologists, the autopsy records being planned and supervised at all stages by a corps of biometricians, the

results obtained would permanently and profoundly alter the outlook of pathological anatomy ever thereafter. But this is, of course, an obvious impossibility. And since it is we must go on as we do; slowly—how slowly—building up out of little and imperfect fragments the body of knowledge of this aspect of human biology.

The biometric methods used were those that have become standard. The original data were transferred to Hollerith punched cards for sorting and tabulation. Such new analytical methods as are used in this paper will be described in connection with their usage.

GENERAL CHARACTERISTICS OF THE MATERIAL

Psychiatric Groups

Table 1 shows the distribution of the material relative to race, sex and psychiatric groups.

TABLE 1

Absolute and Relative Distributions by Psychiatric Groups

PSYCHIATRIC GROUP	WHITE MALES		WHITE FEMALES		NEGRO MALES		NEGRO FEMALES	
	N	Per cent	N	Per cent	N	Per cent	N	Per cent
Cycloids	75	13.29	31	13.60	45	14.66	36	17.31
Paranoids	214	37.94	88	38.60	56	18.24	53	25.48
Schizoids	240	42.56	98	42.98	166	54.07	95	45.67
Epileptoids	35	6.21	11	4.82	40	13.03	24	11.54
Totals	564	100.00	228	100.00	307	100.00	208	100.00

From Table 1 the following points are to be noted:

1. In this sample the schizoids form the largest psychiatric group in the case of both races and both sexes. This accords with general experience. For example, a recent report of the Department of Mental Hygiene of New York[4] says (p. 190): "Dementia praecox furnishes

[4] Department of Mental Hygiene. Annual Statistical Review of Patients with Mental Disease in the State Hospitals and Licensed Institutions, 1931. *New York* (Burland Printing Co.), 1932. Pp. 153-294.

the greatest proportion of cases in all the racial groups." Nearly as numerous as the schizoids in the present experience, both absolutely and relatively, are the paranoids among the whites. But among the Negroes the paranoids are not nearly so numerous relatively as among the whites. Among the whites the cycloids are somewhat more than twice as numerous relatively as are the epileptoids. In the Negroes of this sample these two psychiatric groups are of nearly the same relative size.

2. The psychiatric group pattern of the Negroes in this sample differs from that of the whites in showing a greater relative frequency of cycloids, schizoids, and epileptoids, accompanied by a marked lower relative frequency of paranoids. This result appears generally consonant with what we know of American Negro psychology. As a people they would seem less likely than whites to produce paranoiacs.

3. The racial difference in psychiatric grouping may be shown in another way. Of all the persons included in the sample 60.6 per cent are white and 39.4 Negroes. But of the 411 paranoids in the sample 73.5 per cent are whites and 26.5 per cent Negroes. There are in total 599 schizoids in the sample, of whom only 56.4 per cent are white while 43.6 per cent are Negroes. Of the 110 epileptoids only 41.8 per cent are whites as against 58.2 per cent Negroes. Finally in the cycloid group 56.7 per cent are whites and 43.3 per cent Negroes.

4. The agreement between males and females among the whites in this sample in respect of relative frequency of psychiatric types is extremely close. It is less close among the Negroes.

AGE

The distributions of variation in age of the several groups and classes of this material are shown graphically in Fig. 1, the frequencies being reduced to percentage form for comparison.

The biometric constants relative to the age of the persons in the present sample, by race, sex, and psychiatric groups are shown in Table 2.

All the individuals in the sample were adults, with the exception of four who died in the age group 15-19 years.

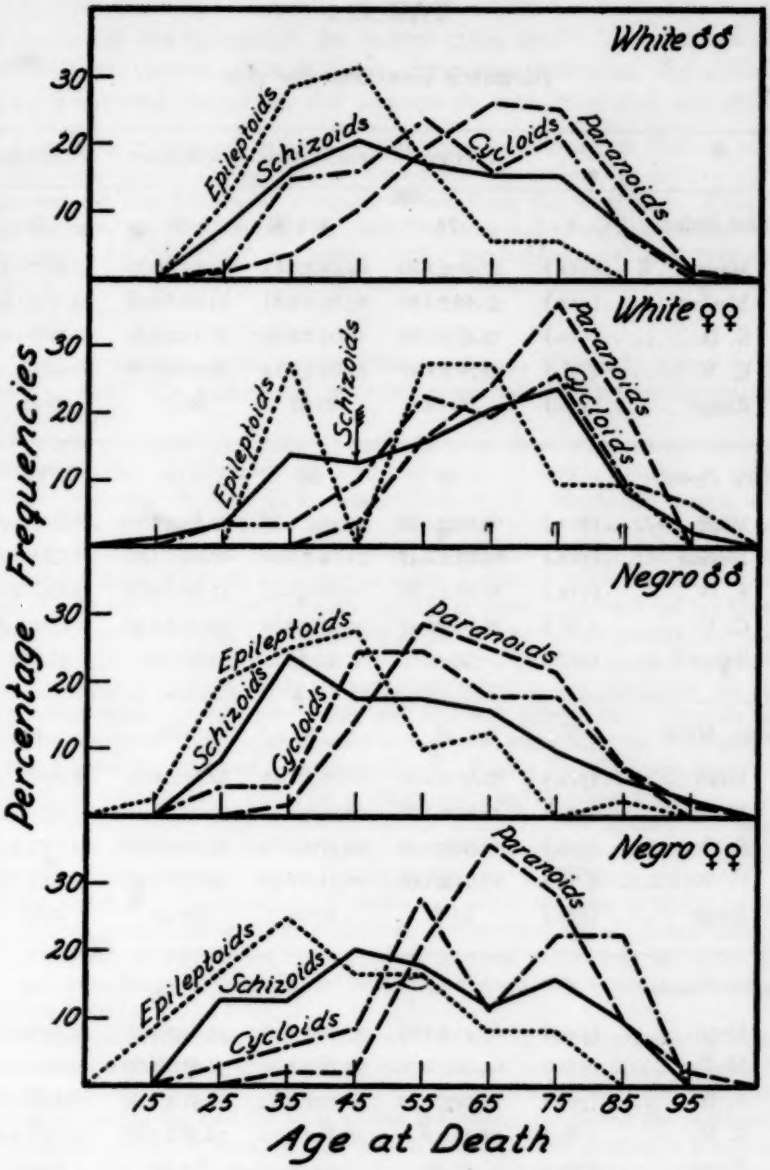

FIG. 1. PERCENTAGE FREQUENCY DISTRIBUTIONS OF AGE

TABLE 2

Biometric Constants for Age

		CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White Males	*N*	75	214	241	35
Mean	(yrs.)	57.93±1.20	64.95±0.65	54.50±0.76	44.43±1.47
Median	(yrs.)	57.50±1.50	65.89±0.81	53.29±0.95	43.18±1.84
S. D.	(yrs.)	15.47±0.85	14.05±0.46	17.49±0.54	12.86±1.04
C. V.	(%)	26.70±1.57	21.63±0.74	32.09±1.08	28.94±2.52
Range	(yrs.)	29-84	26-93	20-97	20-76
White Females	*N*	31	88	97	11
Mean	(yrs.)	65.00±1.97	70.45±0.78	59.85±1.20	56.82±3.22
Median	(yrs.)	65.83±2.47	71.88±0.98	62.25±1.50	58.33±4.04
S. D.	(yrs.)	16.26±1.39	10.86±0.55	17.59±0.85	15.85±2.28
C. V.	(%)	25.01±2.27	15.42±0.80	29.39±1.54	27.89±4.31
Range	(yrs.)	29-91	44-89	19-92	31-81
Negro Males	*N*	45	56	166	40
Mean	(yrs.)	57.67±1.50	62.86±1.15	52.11±0.94	42.25±1.58
Median	(yrs.)	56.82±1.88	62.14±1.44	50.34±1.18	40.91±1.98
S. D.	(yrs.)	14.96±1.06	12.77±0.81	17.90±0.66	14.83±1.12
C. V.	(%)	25.94±1.96	20.31±1.35	34.35±1.41	35.10±2.96
Range	(yrs.)	25-81	37-94	20-97	15-87
Negro Females	*N*	36	53	95	24
Mean	(yrs.)	64.44±1.83	67.26±1.03	53.84±1.28	42.50±2.33
Median	(yrs.)	65.00±2.29	67.11±1.29	52.65±1.60	40.00±2.92
S. D.	(yrs.)	16.32±1.30	11.09±0.73	18.51±0.91	16.89±1.64
C. V.	(%)	25.33±2.14	16.49±1.11	34.38±1.87	39.74±4.44
Range	(yrs.)	25-86	39-90	21-85	17-74

In both races and sexes the paranoids exhibit the highest mean age at death and the epileptoids the lowest mean age.[5] The cycloids and schizoids are intermediate between these two extremes, the cycloids living somewhat longer on the average in each race and sex group.

Figures for average age at death in New York State Hospitals (*loc. cit. supra*, p. 198) show roughly similar relations, though the data are not separated by sex or race, and the classification of psychoses differs from that used here. Thus for 1931 the mean age at death for their class "Paranoia and paranoic conditions" was 70.3 years; for "Epileptic" 47.5 years; with "Manic-depressive" and "Dementia praecox" falling in between these extremes with means respectively of 48.1 years and 53.3 years.[5a]

[5] Another example of the sad imperfections that so frequently appear in this world of ours! The meanest and most dangerous class of the mentally deranged live the longest.

[5a] While this paper was going through the press there appeared an extremely interesting paper by Malzberg (A statistical study of age in relation to mental disease. *Mental Hyg.*, Vol. 19, pp. 449-476, July 1935). Malzberg's results, while having to do with age at first admission of patients to the New York State hospitals for mental diseases during the fiscal years 1929 to 1931 (28,689 of such patients in total), bring out a number of points worthy of brief discussion in connection with our results here presented for age at death. He finds for his manic-depressive psychosis group (corresponding in part to our cycloid group) mean ages at first admission of 38.3±0.2 years for males, and 36.2±0.2 years for females. For his dementia praecox group (roughly equivalent to our schizoids) the corresponding means are 31.8±0.1 years and 36.5±0.1 years. His "Paranoia and paranoic conditions" group give male and female mean ages at admission of 50.1±0.7 years and 50.5±0.6 years respectively. Finally his "Epileptic psychoses" group gives corresponding means of 35.3±0.5 years and 35.9±0.6 years.

Now in considering these figures in relation to those of our Table 2 it is necessary to note first of all that Malzberg's classification of the psychoses is much finer than ours, including 22 rubrics (of which one is "Without psychosis") in place of our four. In consequence it results that out of his total of 28,689 patients only 12,211, or 42.6 per cent fall in the four groups cited above. In our material practically all of the persons corresponding to those included in his other 57.4 per cent have been put, on individual behavioristic grounds, into one or another of the four main categories cited.

Keeping this fact in mind we note that of these four major groups the highest mean age at admission is the paranoid, just as in our material this group has the highest mean age at death. The cycloids and schizoids show about the same mean ages at admission, the cycloids being a little the higher, paralleling the relationship of these two groups in mean age at death as shown by our material. Malzberg's epileptoid group shows a proportionately somewhat higher mean age at admission, relative to the other groups, than appears in the mean ages at death from our data. This suggests the same thing that we have seen above on other grounds, namely that the epileptic psychosis tends markedly to shorten life.

Among the whites of both sexes the schizoids are the most variable psychiatric group, both absolutely and relatively, in respect of age at death. Among the Negroes the same thing is true so far as concerns absolute variability as measured by the standard deviation. The least variable psychiatric group relatively in age at death is the paranoid, in both races and sexes.

While there is some skewness in certain of the age distributions at death, as indicated by the differences between means and medians, generally it is not statistically significant having regard to the probable errors involved.

Preliminary analysis of the data, by comparison of those under 50 years of age at death with those over 50 years, demonstrated that there was no significant age change, within the age range of our data, of the weights of the organs with which we are dealing in this material except the ovary, and therefore we have felt justified in dealing with the psychiatric groups as wholes without further age division.

Table 2 shows the lowest age at death in each group. This figure varies between 15 years (in the Negro male epileptoids) and 44 years (in the white female paranoids). It thus is apparent that in this material exists a group of persons who suffered no infant mortality, nor any mortality whatever up to the age indicated by the lower range limit figure in each group. With the help of a life table it is then possible to obtain an answer to the question of whether the individuals in each psychiatric group lived, on the average, more or less long than the normal expectancy of the general population groups from which they were drawn, having regard to their freedom from the mortality of early life. In order to make such comparisons it is only necessary to extract from the appropriate life table the proper value of $\mathring{e}_x+x$, and see by how much and in what direction it differs from the observed mean age at death recorded in Table 2. The results of such comparisons are set forth in Table 3. In this table $\mathring{e}_x$ values, from which the $\mathring{e}_x+x$ figures of the second column are derived, were taken from the following of Glover's[6] United States life tables:

For White Males: Table 9, pp. 68, 69 (White Males in O. R. S.: 1910)
For White Females: Table 12, pp. 74, 75 (White Females in O. R. S.: 1910)
For Negro Males: Table 35, pp. 120, 121 (Negro Males in District of Columbia: 1901-1910)
For Negro Females: Table 36, pp. 122, 123 (Negro Females in District of Columbia: 1901-1910)

[6] Glover, J. W. United States Life Tables 1890, 1901, 1910, and 1901-1910. *Washington* (Gov't Printing Office) 1921.

TABLE 3

Achieved and Expected Mean Duration of Life

GROUP	LOWEST BIRTHDAY BEYOND WHICH ALL INDIVIDUALS IN GROUP LIVED (*years*)	MEAN AGE AT DEATH EXPECTED FROM LIFE TABLES e_x+x (*years*)	MEAN AGE AT DEATH ACTUALLY OBSERVED (*years*)	EXCESS (+) OR DEFECT (−) OF OBSERVED MEAN AGE AT DEATH AS COMPARED WITH EXPECTED (*years*)	PERCENTAGE GAIN OR LOSS IN LIFE DURATION RELATIVE TO EXPECTANCY (*per cent*)
Negro female cycloids	25	56.26	64.44	+ 8.18	+14.5
Negro male cycloids	25	52.09	57.67	+ 5.58	+10.7
Negro female paranoids	39	61.73	67.26	+ 5.53	+ 9.0
Negro male paranoids	37	57.83	62.86	+ 5.03	+ 8.7
Negro male schizoids	20	49.78	52.11	+ 2.33	+ 4.7
White male paranoids	26	64.00	64.95	+ .95	+ 1.5
White female paranoids	44	70.21	70.45	+ .24	+ 0.3
Negro female schizoids	21	54.56	53.84	— .72	— 1.3
White female cycloids	29	66.74	65.00	— 1.74	— 2.6
White female schizoids	19	64.71	59.85	— 4.86	— 7.5
Negro male epileptoids	15	48.10	42.25	— 5.85	—12.2
White male cycloids	29	64.65	57.93	— 6.72	—10.4
White male schizoids	20	62.71	54.50	— 8.21	—13.1
Negro female epileptoids	17	52.77	42.50	—10.27	—19.5
White female epileptoids	31	67.18	56.82	—10.36	—15.4
White male epileptoids	20	62.71	44.43	—18.28	—29.2

The items of Table 3 are arranged in descending order (algebraically) of the difference between observed and expected average duration of life.

Fig. 2 shows in graphic form the differences (in years) of the mean life durations of each of the groups from the life table expectations of the same groups.

Table 3 and Fig. 2 bring out a number of points of considerable interest. In the first place it is seen that in both races and both sexes the paranoids experienced a mean duration of life greater than that of the actuarially comparable part of the general population, by insig-

nificantly small amounts in the whites, but by substantial amounts in the Negroes. In other words the paranoids in this experience are not only long-lived as compared with the other psychiatric groups, as we have already seen, but are, on the average, actually longer-lived than people in general. This result suggests the odd paradox that paranoia seems to be a *disease* that *per se* conduces to long life. Whether or not this is really and generally so, at least it appears clear that insofar as the present data are to be trusted paranoia is certainly not detrimental to life duration.

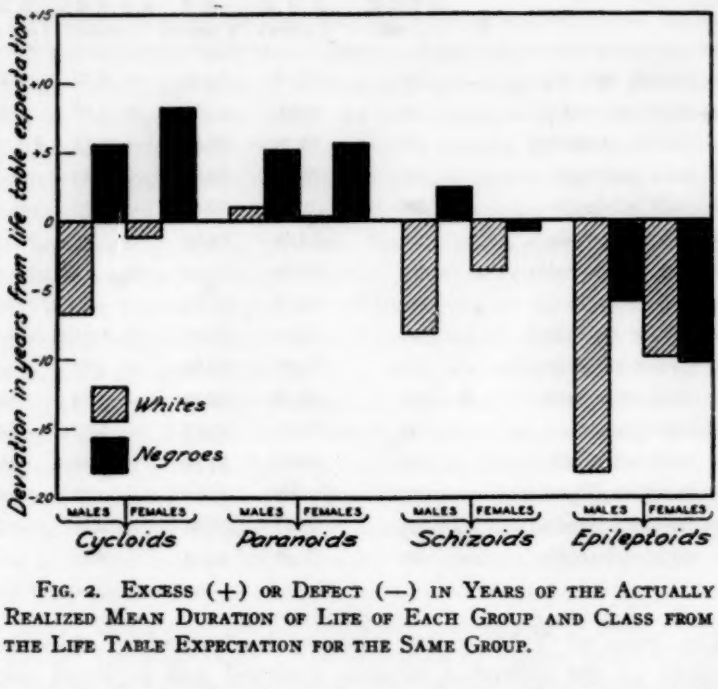

FIG. 2. EXCESS (+) OR DEFECT (—) IN YEARS OF THE ACTUALLY REALIZED MEAN DURATION OF LIFE OF EACH GROUP AND CLASS FROM THE LIFE TABLE EXPECTATION FOR THE SAME GROUP.

Precisely the opposite picture is presented by the epileptoids in this sample. There, in all four races and sex groups, the mean duration of life is curtailed by amounts ranging from 12 to 29 per cent of normal expectancy. This finding accords well with general experience of epilepsy.

In some ways the most remarkable phenomenon shown by Table 3 is the relative actuarial superiority generally exhibited by the Negroes in these psychiatric groups over the corresponding whites. The mean

ordinal position of the 8 Negro groups in Table 3, as arranged in descending order of relative life duration, is 6 as against 11 for the 8 white groups. Negroes, in general, have a normal life expectancy definitely less than that of whites, under American conditions of life. As a rough index of the amount of this deficiency in longevity we have averaged the expectation of life at 2 years[7] given by Foudray[8] and Glover (*loc. cit.*) in 43 life tables for whites and 8 life tables for Negroes. For whites the mean after-life at age 2 is 58.23±.25 years in males and 59.85±.18 years in females. The corresponding means for Negroes are 45.78±.87 years and 46.81±.48 years, indicating respectively 21.4 per cent and 21.8 per cent shorter average life durations in Negroes than in whites. But in spite of this general inferiority of the Negro in mean duration of life it is seen in Table 3 that the Negro cycloids and paranoids of both sexes in this experience, and in addition the Negro male schizoids, all show substantial increases in their achieved mean life duration over the life table expectancy generally observed for their race. We are not certain as to the explanation of this phenomenon, but the suggestion is that it may possibly be mainly accounted for on the following grounds: First, that the average duration of stay of these patients in St. Elizabeth's Hospital was probably fairly long, this being usually the case in psychiatric hospitals where a great part of the population is incurable. Second, that in the case of the Negro patients the quiet, regular life of the Hospital, with good food, cleanliness and general sanitation, probably provided a far more hygienic environment than they had ever experienced in their lives before entrance, and than Negroes in general commonly experience. Third, that this contrast in conditions of living inside the Hospital and outside was greater for the Negro than for the white patients, and might well account, in considerable part at least, for the relative superiority of the Negro.

Certain comparisons of the mean age at death of these psychiatric patients as given in Table 2 with the duration of life data assembled in a comparative table by Pearl and Pearl[9] may be instituted with interest

[7] Taken because the expectation of life at 2 years is generally, though not in quite all cases, higher than at any other age before or after, and because by so doing we are forgiving the Negroes the sins of their terrible infant mortality.

[8] Foudray, E. United States Abridged Life Tables 1919-1920. *Washington* (Gov't Printing Office) 1923.

[9] Pearl, R., and Ruth D. Pearl. The Ancestry of the Long-lived. *Baltimore* and *London* (Johns Hopkins and Oxford Univ. Presses) 1934. Pp. xiii + 168.

and profit. In the following discussion Item Nos. refer to Table 17 (pp. 87-94) of the work cited, where full bibliographic references to the cited figures are given. We note first that white male paranoids of the present material fall in mean age at death at almost identically the same point as all fathers in the Hyde Genealogy (Item 17) and more than a year higher than a sample of fathers in Burke's Landed Gentry (Item 19). Even the Negro male paranoids have a mean age at death not significantly different from that of fathers in the Whitney family (white, upper middle class) (Item 22). The white female paranoids of this material have a mean age at death substantially identical with that of English middle class mothers (Item 35), and less than three years below that of American mothers of nonagenarians and centenarians (Item 31). The Negro female paranoids have a mean duration of life about the same as that of white urban American mothers (Item 39), and definitely above that of white mothers in the Peirce (Item 42), Hyde (Item 46), or Whitney (Item 47) genealogies. These comparisons support very clearly the result already brought out in other ways that, so far as the present material is concerned, the paranoids are a superior group in respect of longevity, especially when it is remembered that parents, like our insane hospital population, are not subject, as a class, to mortality in infancy, childhood, or youth.

BODY LENGTH

As has already been pointed out body length measured on the cadaver is not the same thing as stature measured from the living person by standard anthropometric techniques. This point must be kept in mind in all comparisons. Naturally the body lengths measured on the dead will be a fairly close approximation to the true stature of the same persons in life, and since we cannot get the true statures we are compelled to use the others as a substitute.

Table 4 gives the biometric constants for body length of the persons included in the present material.

From Table 4 it appears that in the males of both whites and Negroes in the present sample the schizoids have the shortest mean body length and the epileptoids the longest. The differences between the means for these two groups, together with their probable errors are as follows:

White males	Diff. = 2.22 ± .96 cm.
Negro males	Diff. = 2.44 ± 1.06 cm.

Among the females the situation is not so regular. The greatest white female body length is that for the schizoids, and the smallest that for the cycloids. In the Negro females the cycloids exhibit the

TABLE 4

Biometric Constants for Body Length

		CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White Males	*N*	70	211	234	34
Mean ..... (cm.)		170.16±0.49	170.91±0.32	169.99±0.39	172.21±0.88
Median ..... (cm.)		169.60±0.61	170.66±0.40	170.39±0.49	172.50±1.10
S. D. ..... (cm.)		6.03±0.34	6.81±0.22	8.79±0.27	7.57±0.62
C. V. ..... (%)		3.55±0.20	3.99±0.13	5.17±0.16	4.39±0.36
Range ..... (cm.)		157-181	151-190	143-194	154-188
White Females	*N*	31	86	96	11
Mean ..... (cm.)		156.53±0.71	157.33±0.51	157.97±0.51	157.50±1.68
Median ..... (cm.)		156.07±0.89	157.00±0.64	157.14±0.64	158.50±2.10
S. D. ..... (cm.)		5.88±0.50	7.05±0.36	7.47±0.36	8.26±1.19
C. V. ..... (%)		3.75±0.32	4.48±0.23	4.73±0.23	5.24±0.76
Range ..... (cm.)		142-167	137-170	140-183	142-170
Negro Males	*N*	41	54	162	39
Mean ..... (cm.)		170.30±0.77	170.65±0.66	168.27±0.38	170.71±0.99
Median ..... (cm.)		170.23±0.97	170.00±0.83	168.38±0.47	171.88±1.24
S. D. ..... (cm.)		7.33±0.55	7.22±0.47	7.08±0.27	9.16±0.70
C. V. ..... (%)		4.30±0.32	4.23±0.28	4.21±0.15	5.37±0.41
Range ..... (cm.)		156-183	153-190	147-185	146-186
Negro Females	*N*	36	52	94	24
Mean ..... (cm.)		160.14±0.68	156.73±0.63	159.47±0.45	153.96±1.18
Median ..... (cm.)		159.17±0.85	156.67±0.79	159.26±0.57	154.44±1.48
S. D. ..... (cm.)		6.07±0.48	6.75±0.45	6.49±0.32	8.60±0.84
C. V. ..... (%)		3.79±0.30	4.31±0.29	4.07±0.20	5.58±0.55
Range ..... (cm.)		150-173	145-177	144-173	122.5-165.0

largest mean and the epileptoids the smallest. The differences with their probable errors are:

White females	Diff. = 1.44 ± .87 cm.
Negro females	Diff. = 6.18 ± 1.36 cm.

The four differences exhibited are the extremes to be found between the means of Table 4. No one of them except the last can be regarded as statistically significant, having regard to probable errors. We are not justified, however, in concluding from this fact that there may not be real group differences in body length between different types of psychiatric patients. All that can be said is that if there are in general such inter-group differences the present material is inadequate in amount to demonstrate them.

With one or two exceptions there are no statistically significant or substantial differences in mean body length between whites and Negroes of the same sex, in any of the psychiatric groups. The cycloid Negro females are 3.61±.98 cm. greater in mean body length than the cycloid white females, but generally in this sample the whites and Negroes were on the average plainly of very nearly the same height.

The general impression made by the means of Table 4 is that the individuals in this sample are somewhat below the average in body length. Hrdlička[10] reports (p. 75) the average stature of his Old American males to be 174.3 cm., and for females 161.85 cm. All the means of Table 4 are below these values, and in most cases by amounts too large to be probably explained by the fact that we are here dealing with post-mortem rather than living measures. In the case of the males we can examine the position of the groups relative to body length from the long comparison series recently compiled by Pearl and Ciocco.[11] Relative to their Table 5 (pp. 670-676) we find that all of the white male means of Table 4 *supra* fall between Item No. 44 (Draft recruits with hemorrhoids) and Item No. 62 (Johns Hopkins Hospital cardiacs), the total number of items in the Pearl-Ciocco comparison table being 66. The psychiatric patients of the present sample are thus plainly relatively short people. Neglecting the white male psychiatric group with greatest

[10] Hrdlička, A. The Old Americans. *Baltimore* (Williams and Wilkins) 1925. Pp. xiii + 436.

[11] Pearl, R., and A. Ciocco. Studies on constitution. II. Somatological differences associated with disease of the heart in white males. HUMAN BIOLOGY, Vol. 6, pp. 650-713, 1934.

mean body length (the epileptoids) the remaining three groups fall between Items 54 and 62 of the Pearl-Ciocco table. We have not, unfortunately, any corresponding American comparison tables for Negroes or for females. But Hrdlička (*loc. cit.*, p. 72) computes from the Medico-Actuarial [12] data a mean stature making allowance for shoes of 161.3 cm. for adult women. This is greater than any mean female body length in Table 4 *supra*, white or Negro. This again indicates the relative shortness of the psychiatric patients in the present sample.

The study by Pearl and Ciocco cited above, as well as their discussion of Draper's [13] data, indicates quite clearly that urban general hospital populations tend to be undersized in respect of stature. The present data suggest that the same thing is true of psychiatric patients as well as those with other types of disease. This will be made clear from Table 5, which is compiled and rearranged in descending order of male mean statures from Draper's data.

TABLE 5

Mean Statures (from Draper, p. 334)

GROUP	MEAN STATURE (CM.)	
	Males	Females
Tuberculosis	173.38	159.10
Pernicious anemia	173.10	158.78
Gall-bladder disease	170.79	155.62
Nephritis and hypertension ...	167.86	161.16
Asthma	167.22	159.04
Gastric and duodenal ulcer	164.28	156.00

It is evident by comparing Table 4 with Table 5 that the St. Elizabeth's Hospital patients here dealt with exhibit mean body lengths of about the same general order of magnitude as Draper's general hospital groups. Taking unweighted averages of Draper's data as set forth in Table 5 it appears that the mean male stature for all 6 groups together is 169.44 cm. and the mean female stature is 158.28 cm., the female average thus being 93.42 per cent of the male. The corresponding fig-

[12] Medico-Actuarial Mortality Investigation. 1912-1914. *New York*. Vols. 1-4.

[13] Draper, G. Human Constitution. A Consideration of Its Relation to Disease. *Philadelphia* (W. B. Saunders Co.) 1924. Pp. vi + 345.

ures for unweighted average white body length for all four psychiatric groups of Table 4 is 170.82 cm. for males and 157.33 cm. for females, the latter average being 92.11 per cent of the former. Hrdlička's reduction of the Medico-Actuarial data referred to above gives the mean female stature as 93.72 per cent of the male.

So it is seen, in sum, that not only is the St. Elizabeth's Hospital population, as indicated by the present sample, generally undersized in respect of body length, but the females are relatively more inferior in this respect than the males.

Turning now to variation in body length it is seen from Table 4 that generally the epileptoids constitute the most variable group relative to this character. The white males form the only exception to this statement, where the schizoids are insignificantly more variable than the epileptoids. The least variable groups in body length are generally the cycloids, the Negro males forming the only exception. There the cycloids, paranoids, and schizoids show substantially equal variability.

Relatively these psychiatric patients appear to be a little more variable in body length, as judged by the coefficient of variation, than samples of general populations of the living usually are in stature. From manuscript comparison tables in the senior author's files it appears that for samples of adult living males coefficients of variation in stature range between 3.20 per cent and 4.55 per cent. Of the 8 coefficients of variation in Table 4 six lie within these limits and two above. A similar manuscript comparison table for females gives coefficients of variation in adult living stature ranging from 3.69 to 4.77 per cent. Again six of the coefficients for females in Table 4 lie within this range and two above.

BODY WEIGHT AND BODY WEIGHT RATIO

Again it must be emphasized that we are here dealing with post-mortem data from cadavers. Naturally some of these patients will have been subject to long and wasting last illnesses before they reached the autopsy table. Under such circumstances it will not be a matter of surprise if their body weights turn out, on the average, to be below average weights of the living, even when the latter are drawn from general hospital populations.

Table 6 gives the biometric constants for body weight, together with the mean body weight ratios for each group. By body weight ratio is meant the number of kilograms of body weight per 10 cm. of body length (10 $\times$ body weight/body length).

TABLE 6

Biometric Constants for Body Weight

		CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White Males	*N*	70	207	230	33
Mean	(kg.)	56.00±0.99	56.16±0.63	49.39±0.56	61.97±2.19
Median	(kg.)	54.29±1.24	54.45±0.79	47.59±0.70	57.73±2.75
S. D.	(kg.)	12.32±0.70	13.43±0.45	12.52±0.39	18.67±1.55
C. V.	(%)	22.01±1.31	23.91±0.84	25.35±0.85	30.12±2.72
Range	(kg.)	32.5-85.0	33.0-95.0	25.0-115.0	28.0-104.0
Body weight ratio	(kg.)	3.29	3.29	2.91	3.60
White Females	*N*	31	86	95	11
Mean	(kg.)	43.39±1.74	42.67±1.87	39.95±1.20	38.64±1.99
Median	(kg.)	38.75±2.18	46.19±2.35	36.71±1.50	37.00±2.50
S. D.	(kg.)	14.39±1.23	25.75±1.32	17.34±0.85	9.79±1.41
C. V.	(%)	33.17±3.14	60.35±4.08	43.42±2.49	25.34±3.87
Range	(kg.)	22-74	25-100	20-102	26-55
Body weight ratio	(kg.)	2.77	2.71	2.53	2.45
Negro Males	*N*	40	50	157	39
Mean	(kg.)	56.50±1.38	58.40±1.50	46.08±0.55	54.74±1.59
Median	(kg.)	55.39±1.73	58.00±1.88	44.92±0.69	54.17±2.00
S. D.	(kg.)	12.95±0.98	15.70±1.06	10.26±0.39	14.76±1.13
C. V.	(%)	22.92±1.82	26.88±1.94	22.26±0.89	26.96±2.20
Range	(kg.)	35-91	36-105	21-75.9	34-85
Body weight ratio	(kg.)	3.32	3.42	2.74	3.21
Negro Females	*N*	35	52	94	24
Mean	(kg.)	53.29±1.67	47.50±1.04	42.77±2.10	46.25±1.61
Median	(kg.)	51.25±2.09	46.32±1.30	39.74±2.63	46.25±2.01
S. D.	(kg.)	14.64±1.18	11.07±0.73	12.90±1.48	11.66±1.14
C. V.	(%)	27.47±2.38	23.31±1.62	30.15±1.61	25.21±2.61
Range	(kg.)	29-80	29-75	23.2-86.0	16.3-66.5
Body weight ratio	(kg.)	3.33	3.03	2.68	3.00

From Table 6 it appears that in general the cycloids and paranoids agree closely in mean body weight, just as they do in mean body length (Table 4). The only exception to this rule is in the Negro females, where the paranoids exhibit a lower mean body weight. In all four race-sex groups the schizoids show a lower mean body weight than the cycloids and paranoids. Relative to mean body weight in the epileptoids there is an interesting sex difference. The males, both white and Negro, exhibit means not significantly different from those of the cycloids and paranoids, while the female means are lower than the corresponding ones for the other two groups. The female epileptoid samples are, however, so small as to make it uncertain whether this difference really means anything.

The body weight distributions are not perfectly symmetrical, as is shown by the differences between the means and the medians. But in no case can the degree of skewness be regarded as statistically significant, having regard to the probable errors.

The body weight ratio is a fair index of stoutness of body build in general. On this basis it appears that in all four psychiatric types the white males are, at death, of stouter build, on the average, than the white females. The differences in this respect between the sexes of the Negroes in this material are, on the whole, not so marked or definite as they are in the whites. The body weight ratio is generally smaller in the schizoids than in any other of the psychiatric types, indicating a slimmer type of body build.

If the weight ratio figures of Table 6 are compared with those for living persons in Pearl and Ciocco's (*loc. cit.*, pp. 677-680) comparison Table 6, it is clear that this ratio is not dimensionally equivalent in the living and the dead, chiefly because of the rapid loss of water at death and immediately after death. The highest mean body weight ratio from the present autopsy data is 3.60 (white male Epileptoids). But this falls between groups 61 and 62 out of a total of 66 groups in the Pearl-Ciocco table. For obvious reasons the same relationship holds relative to mean absolute body weight. The present mean body weights find their counterparts only at the bottom of Pearl and Ciocco's comparison Table 4 (*loc. cit.*, pp. 663-669) for mean body weight in the living, in such groups as "Draft recruits underweight," "Draft recruits with defective physical development," "Draft recruits with tuberculosis," etc.

In short, as has been emphasized earlier in this paper, measurements upon autopsy material such as the present, cannot be directly compared with measurements on the living.

Table 7 gives the coefficients of correlation between body length and body weight for the present material. On account of the small size of the samples, and the relatively high variability of the material the female epileptoid groups, both white and Negro, are omitted from these and all following organ weight tables.

TABLE 7

Correlation Coefficients (r) Between Body Length and Body Weight

	CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White males	+.305±.082	+.351±.047	+.257±.044	+.543±.117
White females	+.363±.121	+.271±.073	+.514±.070	.....
Negro males	+.332±.108	+.431±.096	+.269±.054	+.594±.108
Negro females	+.080±.114	+.281±.094	+.196±.070	.....

On the whole the values of r in Table 7 run rather evenly from group to group, but they tend to be lower than is usual for stature-body weight correlation in the living. Pearson (*Proc. Roy. Soc. Lond.*, 65: 25, 1899-1900) finds $r = +.486 \pm .016$ for adult males, for example. Davenport and Love (*Army Anthropology*, 1921:269) found for recruits, white and colored together, values of $+.4810 \pm .0006$ at mobilization and $+.5198 \pm .0017$ at demobilization. Three only of the values in Table 7 (male epileptoids and white female schizoids) get up into this range. It is probable that the fact that we are dealing with autopsy material is in some part responsible for the relatively low values of the coefficients in Table 7.

Within Table 7 itself it is impossible to assert that there are any significant differences between the four psychiatric groups in respect of length-weight correlations. The epileptoid male coefficients are higher than any of the others, but the samples are so small that the differences are not surely significant.

THE ADRENALS

We may well begin the discussion of the endocrine organs with the adrenals for two reasons. The internal secretion from its medulla,

epinephrine, is of prime importance in integrating the organism to meet effectively emotional stresses and strains, and physiological and psychological emergencies generally. One of the most striking characteristics of the psychiatric patient, broadly speaking, is his inadequacy in just this particular. Furthermore the secretion of the adrenal

TABLE 8

Right Adrenal Weight for Different Psychiatric Groups

		CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White Males	*N*	57	183	195	30
Mean .....(gms.)		7.92±0.18	7.47±0.11	7.19±0.09	7.80±0.31
Median .....(gms.)		7.93±0.23	7.26±0.14	6.89±0.12	6.86±0.39
S. D. .....(gms.)		2.02±0.13	2.19±0.08	1.96±0.07	2.53±0.22
C. V. .....(%)		25.46±1.71	29.29±1.12	27.30±1.00	32.46±3.11
Range .....(gms.)		4.0-12.0	2.3-13.7	2.6-12.5	3.7-12.8
White Females	*N*	26	80	84	..
Mean .....(gms.)		7.04±0.31	6.76±0.14	6.42±0.13	..
Median .....(gms.)		6.67±0.39	6.56±0.17	6.39±0.16	..
S. D. .....(gms.)		2.34±0.22	1.83±0.10	1.72±0.09	..
C. V. .....(%)		33.26±3.44	27.04±1.54	26.80±1.49	..
Range .....(gms.)		3.2-12.8	1.7-10.5	2.4-10.5	..
Negro Males	*N*	37	41	145	37
Mean .....(gms.)		6.85±0.23	6.82±0.25	6.53±0.10	7.50±0.21
Median .....(gms.)		6.31±0.29	6.28±0.32	6.38±0.13	7.19±0.26
S. D. .....(gms.)		2.07±0.16	2.40±0.18	1.78±0.07	1.87±0.15
C. V. .....(%)		30.20±2.58	35.26±2.93	27.34±1.16	24.99±2.08
Range .....(gms.)		3.8-12.7	3.0-15.0	2.2-11.1	3.8-13.2
Negro Females	*N*	33	46	83	..
Mean .....(gms.)		6.74±0.21	5.74±0.14	6.20±0.10	..
Median .....(gms.)		6.58±0.27	5.50±0.17	6.02±0.13	..
S. D. .....(gms.)		1.81±0.15	1.40±0.10	1.38±0.07	..
C. V. .....(%)		26.84±2.38	24.42±1.82	22.22±1.22	..
Range .....(gms.)		3.9-12.7	3.3-9.5	3.7-11.7	..

cortex has been shown by animal experimentation to be absolutely essential for the continued maintenance of life itself in the higher vertebrates.

Tables 8 and 9 give respectively the biometric constants for the right and left adrenals, in the present material.

It will be noted that in Tables 8 and 9, and all subsequent similar organ weight tables in this study, the numbers (N) for each race-psychiatric group are smaller, by varying amounts, than the total numbers for the corresponding groups set forth in Table 1 *supra*. This discrepancy arises chiefly because of the fact that the weight of any organ was omitted from the computations when, in the opinion of the pathologist, the organ itself was plainly diseased (lesioned). A few additional omissions are occasioned by failure to record a particular organ weight.

From Tables 8 and 9 it is seen that the recorded weight of the single adrenal gland varied between 1.7 and 17.0 gm. in this material, taking all groups together into account. This is truly a great range of variation, considering that all organs evidently diseased from the viewpoint of the pathologist, have been excluded from the computations. The distributions of adrenal weight variation are generally symmetrical as is shown by comparing the values of means and medians in each table. Such differences as appear between these constants are not significant in comparison with the probable errors of the differences. Not only is the adrenal weight highly variable in general, as has been seen, but it is so when judged by the coefficients of variation for the several groups. These coefficients range from 17.02 per cent for the white male paranoids (left adrenal) to 36.47 per cent for the Negro male paranoids (left adrenal).

With the above general observations we may pass at once to the questions of prime importance relative to adrenal weights to which we want to get answers, insofar as our imperfect data will give them. These are four in number, viz.:

1. Is the total mass of adrenal tissue in the bodies of these psychiatric patients in general greater or less in absolute amount and also relative to body size, than that found in normal persons?

2. Do the different psychiatric groups in this material differ in any regular and significant way from each other in respect of the total mass of adrenal tissue in their bodies, either absolutely or relative to body size, and if so, how?

3. Do the whites and Negroes in this material, as groups, differ in any regular and significant way from each other in respect of the total mass of adrenal tissue in their bodies, either absolutely or relative to body size, and if so, how?

TABLE 9

Left Adrenal Weight for Different Psychiatric Groups

		CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White Males	*N*	57	181	196	30
Mean .....(gms.)		8.01±0.19	7.97±0.07	7.59±0.11	8.13±0.32
Median .....(gms.)		8.21±0.24	7.64±0.09	7.24±0.13	7.60±0.40
S. D. .....(gms.)		2.12±0.13	1.36±0.05	2.24±0.08	2.56±0.22
C. V. .....(%)		26.47±1.79	17.02±0.62	29.47±1.09	31.50±3.00
Range .....(gms.)		3.5-13.6	2.8-16.0	2.7-14.4	4.3-12.7
White Females	*N*	26	80	85	..
Mean .....(gms.)		6.96±0.30	7.13±0.14	6.56±0.16	..
Median .....(gms.)		6.33±0.37	6.77±0.18	6.50±0.20	..
S. D. .....(gms.)		2.24±0.21	1.86±0.10	2.21±0.11	..
C. V. .....(%)		32.18±3.31	26.10±1.48	33.76±1.94	..
Range .....(gms.)		4.2-12.7	3.5-11.8	2.2-15.3	..
Negro Males	*N*	36	43	142	37
Mean .....(gms.)		7.72±0.29	7.24±0.27	7.27±0.12	7.85±0.21
Median .....(gms.)		7.17±0.37	6.79±0.34	6.89±0.15	7.71±0.26
S. D. .....(gms.)		2.60±0.21	2.64±0.19	2.15±0.09	1.88±0.15
C. V. .....(%)		33.73±2.97	36.47±2.98	29.61±1.28	23.91±2.80
Range .....(gms.)		3.8-17.0	3.0-15.1	3.0-12.6	3.9-10.7
Negro Females	*N*	33	45	83	..
Mean .....(gms.)		6.89±0.24	6.41±0.18	6.81±0.13	..
Median .....(gms.)		6.45±0.30	6.23±0.23	6.46±0.17	..
S. D. .....(gms.)		2.04±0.17	1.79±0.13	1.82±0.10	..
C. V. .....(%)		29.65±2.67	27.87±2.13	26.66±1.49	..
Range .....(gms.)		3.7-11.3	2.6-12.3	3.5-12.7	..

4. Do the two sexes in this material differ in respect of total mass of adrenal tissue, absolutely or relatively?

To present the material in form to attack these questions certain derivative tables will be necessary. The first of these is presented as Table 10. It gives the mean *total weights* of adrenal tissue in the several race, sex, and psychiatric groups, got by combining the data of Tables 8 and 9.

TABLE 10

Mean Total Weights; Both Adrenals Together
(In Grams)

RACE AND SEX	CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White males	15.93	15.44	14.78	15.93
White females	14.00	13.89	12.98	....
Negro males	14.57	14.06	13.80	15.35
Negro females	13.63	12.15	13.01	....

Table 11 gives the following data as to relative weight of the adrenals, computed from the absolute figures of Tables 4, 6 and 10:

a. Milligrams of adrenal per centimeter of body length, computed according to the following formula

$$\frac{\text{(Mean weight of right adrenal + Mean weight of left adrenal) in mgm.}}{\text{Mean body length (in cm.)}}$$

b. Milligrams of adrenal per kilogram of body weight, computed as follows:

$$\frac{\text{(Mean weight of right adrenal + Mean weight of left adrenal) in mgm.}}{\text{Mean body weight (in kg.)}}$$

c. Milligrams of adrenal per kilogram of average body weight per 10 cm. of body length, computed as follows:

$$\frac{\text{(Mean weight of right adrenal + Mean weight of left adrenal) in mgm.}}{\text{Mean body weight ratio [= 10 (Mean body weight)/(Mean body length)]}}$$

We are now in position to consider the answers to the questions raised above. The first was as to whether the absolute weight of adrenal tissue was generally greater or less in these psychiatric patients than in normal persons. Practically the only reliable and suitable data for

TABLE 11

Relative Total Adrenal Weights

RACE AND SEX	RELATIVE TOTAL ADRENAL WEIGHTS	CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White males	a. Adrenal weight per cm. of body length.....(mgm.)	94	90	87	93
	b. Adrenal weight per kg. of absolute body weight (mgm.)	284	275	299	257
	c. Adrenal weight per kg. of relative body weight (mgm.)	4842	4693	5079	4425
White females	a. Adrenal weight per cm. of body length.....(mgm.)	89	88	82	...
	b. Adrenal weight per kg. of absolute body weight (mgm.)	323	326	325	...
	c. Adrenal weight per kg. of relative body weight (mgm.)	5054	5125	5130	...
Negro males	a. Adrenal weight per cm. of body length.....(mgm.)	86	82	82	90
	b. Adrenal weight per kg. of absolute body weight (mgm.)	258	241	299	280
	c. Adrenal weight per kg. of relative body weight (mgm.)	4389	4111	5036	4782
Negro females	a. Adrenal weight per cm. of body length.....(mgm.)	85	78	82	...
	b. Adrenal weight per kg. of absolute body weight (mgm.)	256	256	304	...
	c. Adrenal weight per kg. of relative body weight (mgm.)	4093	4010	4854	...

"normals" that may be used for comparison are those of Roessle and Roulet[14] (Table 36, p. 78). Theoretically it would be preferable to use their data for sudden deaths only (p. 77) but these figures are not separated by sex. Consequently we extract for comparison the following means from their Table 36.

TABLE 12

"Normal" Adrenal Weights (Roessle and Roulet) in Gm.

AGE (YRS.)	MALE MEANS	FEMALE MEANS
21-30	13.71	12.97
31-40	13.91	13.02
41-50	13.84	12.00
51-60	13.36	11.65
61-70	13.00	12.14
Over 70	12.16	11.72
Unweighted averages ...	13.33	12.25

Comparing the above normal figures with those of Table 10 for the present series of psychiatric patients, it is at once evident that the means run definitely and rather regularly *higher* in the psychiatric patients. The mean weight of both adrenals combined for all white males in the present material taken from the paper by Freeman (*loc. cit.*, p. 509) is 15.20 gm., and for all white females 13.43 gm. So then it appears that the mean total adrenal weight for adult males in the present series is roughly 114 per cent of that for the adult males in the normal series of Roessle and Roulet. The corresponding figure for adult white females is 110 per cent.

But the psychiatric patients may have been larger persons all around than those comprising Roessle's and Roulet's sample, and had larger adrenals on that account only. It will be necessary to examine relative weights to get information on this point. The only relative comparison possible to make from Roessle's and Roulet's data is as to milligrams of total adrenal per kilogram of body weight. Making the necessary computations we have the results shown in Table 13.

[14] Roessle, R. and F. Roulet. Mass und Zahl in der Pathologie. *Berlin* (Springer) 1932. Pp. vii + 144.

TABLE 13

Milligrams of Adrenals per Kg. of Body Weight (Roessle and Roulet)

AGE (YRS.)	MALE MEANS	FEMALE MEANS
21-30	263	284
31-40	252	278
41-50	265	245
51-60	269	250
61-70	228	245
Over 70	224	266
Unweighted averages ...	250	261

Again it is evident from the most cursory comparison of Table 13 with the figures for white males, line b, and white females, line b of Table 11, that the relative weight of adrenals per kg. of body weight is generally and regularly higher in the psychiatric patients than in the normal series of Roessle and Roulet. Using the unweighted averages of Table 13 and corresponding unweighted averages for white males and females from Table 11 for comparison it appears that the relative total weight of adrenals per kg. of body weight in the psychiatric patients is roughly 112 per cent of that for the "normals" of Roessle and Roulet in the case of males, and 125 per cent in the case of females.

So then the answer to our first question is that, insofar as the series compared may be regarded as representative of mentally diseased and "normal" persons respectively, *it is probable that the total weight of the adrenals, both absolute and relative to body weight, is from 10 to 25 per cent greater in the mentally diseased than in the "normal."* The only alternative conclusion would appear to be that Roessle and Roulet cleaned up their adrenals more carefully before weighing than Freeman did. This seems, on the whole, more improbable than the conclusion stated.

We turn next to our second question, which is as to whether the four psychiatric groups differ in any orderly and significant way among themselves relative to adrenal weight. It is evident from inspection of Table 10 that the absolute mean weight of adrenals descends, from class to class, in the following order: Epileptoids, cycloids, paranoids, and schizoids in the case of the males. The order for the white females is

the same, with omission of the epileptoid class. The unweighted means of the columns of Table 10, both races and sexes together, to give a rough idea of the trend, are:

Epileptoids (male only) 15.64 gm.; cycloids 14.53 gm.; paranoids 13.89 gm.; schizoids 13.64 gm.

The differences from class to class are small, and generally insignificant in comparison with their probable errors in samples of the size here dealt with. But the differences in absolute weight of adrenals between the extreme psychiatric classes, even in the present material, are generally significant (as may be seen from Tables 8 and 9).

The same order of psychiatric groups just demonstrated for mean absolute weight of adrenals also holds, generally speaking, for mean adrenal weight per cm. of body length (cf. Table 11), but is somewhat altered for adrenal weight relative to body weight. There we have, again taking as a rough index of the trends of the present material the unweighted means of the columns of Table 11, both races and sexes together, the following picture:

	Schizoids	*Cycloids*	*Paranoids*	*Epileptoids* *
Mean adrenal weight per kg. of absolute body weight (mgm.)	307	280	275	269
Mean adrenal weight per kg. of relative body weight (mgm.)	5025	4595	4485	4602

* Males only.

Quite clearly the schizoids have the largest mean weight of adrenals relative to either absolute or proportional body weight in the present material. The differences between successive classes are again very small and no particular significance can be attached to them.

A conservative answer to our second question would then seem to be that, so far as mean weight of adrenals, both absolute and relative to body length, is concerned, the epileptoids appear to stand highest (but only males are available) and the schizoids lowest, but all the differences are rather small, amounting to only about 13 per cent in the extreme case. So far as mean adrenal weight relative to body weight is concerned the relationship of the psychiatric classes is just reversed as to the extremes, schizoids standing highest and epileptoids lowest, but again the differences are small. In general there are no very striking differences in adrenal weight, either absolute or relative, between the four psychiatric groups in this material.

Our third question related to the racial differences shown in adrenal weights in this material. Table 10 shows that in absolute weights the whites show uniformly higher values than the Negroes in every group and both sexes except for female schizoids. Taking unweighted means of the values in that table, all groups and both sexes together, we have:

Whites	14.71 gm.
Negroes	13.80 gm.

The Negroes thus have, in this material, adrenals weighing on the average 94 per cent as much as those of the whites. The deficiency of the Negroes is identical in amount (6 per cent) in mean adrenal weight relative to body length. The difference between Negroes and Whites is somewhat larger in respect of mean adrenal weight per kg. of body weight, the Negro unweighted average (271 mgm.) being only about 91 per cent of that for the whites (298 mgm.). The same proportion (91 per cent) also obtains for mean adrenal weight per kg. of relative body weight, the unweighted average for whites being 4907 mgm. and for Negroes 4468 mgm.

We may then conclude that in the present sample of mentally diseased persons the Negroes have smaller adrenals than the whites, both absolutely and relative to stature and absolute and relative body weights, by amounts ranging from 6 to 9 per cent.

The fourth question propounded concerns the position of the two sexes relative to weight of the adrenals. Taking unweighted means, as before, from Table 10 and also in the case for the normals of Table 12, we have, on the basis of the 12 comparable series combined, the following figures:

Mean absolute weight of adrenals in males	= 14.05 gms.
Mean absolute weight of adrenals in females	= 12.76 gms.

The mean female absolute weight of adrenals is thus about 91 per cent of the mean male weight.

Relative to body length the data of Table 11 averaged indicate a small difference, the mean for the males being 87 mgm. per cm. of body length, and that for the females being 84 mgm., the latter figure being about 97 per cent of the former, an unimportant difference.

For comparative adrenal weights in the two sexes relative to absolute body weight the data of Table 13 may be combined with those of Table 11. When this is done it turns out that the position of the sexes is reversed, the males showing an average weight of adrenals per kg. of

body weight of 263 mgm. as against 280 mgm. in the females, the latter figure being about 106 per cent of the former. For the adrenal weights per kg. of relative body weight we have the following unweighted averages from the 6 comparable series of Table 11: Males 4692 mgm. and females 4711 mgm., the female average being thus about 100.4 per cent of the male, or sensibly identical.

In sum, then, it appears on the basis of the evidence here discussed that while the mean weight of the adrenals in the female is absolutely only about 91 per cent of what it is in the male, and is slightly less than in the male per cm. of stature, it is about 6 per cent greater than in the male per kg. of absolute body weight, and is substantially identical in the two sexes in proportion to relative body weight.

A general view of the results to this point relative to the weight of the adrenals is given graphically in Fig. 3, which plots the relative weights of adrenals per kg. of body weight—that is the mass structural adrenal dosage in proportion to body weight.

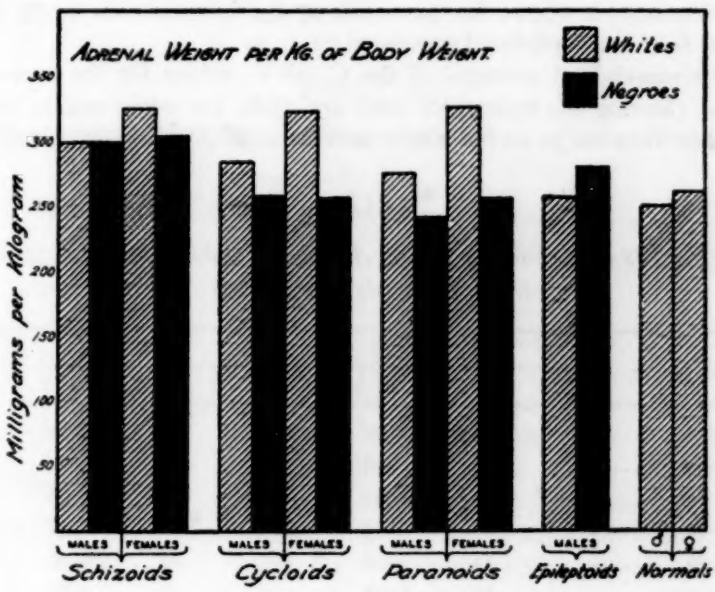

Fig. 3. Relative Adrenal Weights (Means) in Proportion to Body Weight

It is apparent from this diagram that the *differences* between the different psychiatric groups are not very striking, taking the data as a whole. We are constrained to a considerable scepticism as to whether such differences as appear have any real biological significance. It must remain for future and more ample data to determine the point.

Is there a definite tendency towards *asymmetry* between the two sides of the body relative to adrenal weight? The answer is unequivocally in the affirmative. In the 14 comparable series the left adrenal has a higher mean weight than the right gland in 13 cases, by amounts ranging from .09 gm. to .87 gm. The one exception to the rule that the left gland is the heavier is afforded by the white female cycloids, where the right gland is heavier by .09 gm.

Since the different groups of Tables 8 and 9 differ from each other in respect of both means and standard deviations it will be best to assess *comparative variability* on the basis of the coefficients of variation rather than standard deviations. As between the psychiatric groups there appear to be no striking, or even probably significant, differences in comparative variability. The unweighted mean C. of V. for the 8 cycloid groups is 29.72; for paranoids 27.93, for schizoids 27.90, and for the four male epileptoid groups 28.22.

The unweighted averages of the C. of V. values for the race-sex groups (leaving the epileptoids out) are 25.84 for white males, 29.86 for white females, 32.10 for Negro males, and 26.28 for Negro females.

TABLE 14

Coefficients of Variation in Total Adrenal Weight (Computed from Data of Roessle and Roulet)

AGE GROUP	MALES		FEMALES	
	N	C. of V.	N	C. of V.
21-30	166	20.27	97	23.35
31-40	111	19.96	91	22.30
41-50	51	21.32	89	23.08
51-60	26	23.95	84	23.48
61-70	14	19.38	87	24.90
Over 70	11	14.97	57	25.85
Unweighted means	397	19.98	505	23.83

TABLE 15

Values of the Correlation Coefficient (r) Between Adrenal Weights and Body Length

	CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
Right adrenal				
White males	+.106±.089	+.352±.050	+.162±.048	+.197±.123
White females	+.242±.132	+.275±.075	+.376±.074	.....
Negro males	+.176±.111	+.128±.105	+.227±.056	+.417±.111
Negro females	+.301±.117	+.176±.099	+.075±.074	.....
Left adrenal				
White males	+.232±.089	+.614±.050	+.248±.048	+.234±.123
White females	+.301±.132	+.192±.075	+.477±.073	.....
Negro males	+.257±.112	+.296±.103	+.137±.056	+.100±.111
Negro females	+.364±.117	+.240±.101	+.059±.074	.....

TABLE 16

Values of the Correlation Coefficient (r) Between Adrenal Weights and Body Weight

	CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
Right adrenal				
White males	+.258±.090	+.437±.050	+.238±.049	+.352±.125
White females	+.574±.132	+.302±.075	+.576±.074	.....
Negro males	+.311±.114	+.214±.112	+.201±.057	+.220±.111
Negro females	+.214±.119	—.109±.099	+.242±.074	.....
Left adrenal				
White males	+.111±.090	+.360±.051	+.245±.049	+.424±.125
White females	+.621±.132	+.210±.075	+.500±.074	.....
Negro males	+.370±.116	+.321±.109	+.143±.057	+.143±.111
Negro females	+.123±.119	—.051±.101	+.417±.074	.....

Thus in the whites the females are somewhat more variable than the males in adrenal weight, while in the Negroes the opposite is true, in this material. In connection with these results it has seemed desirable to compute from Roessle's and Roulet's data (*loc. cit.* Table 36, p. 78) the coefficients of variation for adult white males and females shown in Table 14.

The figures of Table 14 confirm our finding of greater variability in white females than in the males. But the absolute values of the coefficients of variation of Table 14 are definitely lower for both sexes than those of Tables 8 and 9 for the mentally diseased. A part of this lower variability may possibly be accounted for by the fact that Table 14 is derived from the weights of the glands taken together, while Tables 8 and 9 are based upon single glands separately weighed.

The *correlations* of adrenal weights with body length and body weight are set forth in Tables 15 and 16. The regressions in all cases are linear within limits of sampling errors.

There is plainly considerable variation in the values of the correlations of adrenal weights with body size in Tables 15 and 16. The most conspicuous point of uniformity is in respect of sign; all but two of the 56 coefficients are positive. Twenty-four out of the 56 are three or more times their respective probable errors, and therefore probably significantly different from zero.

The distribution of the correlation coefficients is shown in orderly form in Table 17.

TABLE 17

Distributions of the Coefficients of Correlation of Adrenal Weights With Body Length and Weight

VALUES *of r*	WITH BODY LENGTH	WITH BODY WEIGHT
—.10-.19	—	1
0-(—).09	—	1
0-(+).09	2	—
+.10-.19	9	4
+.20-.29	9	9
+.30-.39	5	6
+.40-.49	2	3
+.50-.59	—	3
+.60-.69	1	1
Totals	28	28

Evidently there is a definite, if not very marked, tendency for adrenal weight, so far as concerns the present material, to be more highly correlated in the positive sense with body weight than with body length.

As between sexes, or between the various psychiatric groups, or between the two races there appear to be no marked or regular differences in degree of correlation between adrenal weight and body length or body weight.

THYROID

Too little or too much of the thyroid hormone may, according to the statements of clinicians, have profound and far-reaching effects upon personality. Hoskins[15] says (pp. 80-81) regarding the former condition:

> The effects of thyroid deficiency on the personality vary widely from case to case. The subjects are rather commonly depressed in mood, a consequence perhaps of the realization of their handicaps. This depression may go to the extent of genuine psychosis, a condition scarcely to be differentiated from the manic depressive type. In any case, an element of dissatisfaction with life and distrust of his fellow-men makes for unhappiness of the patient. In severe cases delusions and hallucinations of hearing, sight, smell and taste may occur. The patient may find himself uncontrollably impelled to bizarre conduct. In the most severe cases the subjects become hallucinated and confused. In short, a condition may develop that is clinically indistinguishable from the ominous psychosis, dementia praecox. It is interesting that Hoskins and Sleeper have reported the occurrence of recognizable degrees of thyroid deficiency in about ten per cent of a series of patients suffering from this psychosis. In these cases considerable degrees of improvement were not infrequently seen following thyroid medication. There are recorded in the literature several instances of complete cure of apparently genuine dementia praecox under such treatment—but many failures have also occurred.

Regarding hyperthyroidism the same author (*loc. cit.*, pp. 93-94) makes the following statement:

> Nervous and psychical excitement become more marked, even leading in some cases to major psychoses. Bleuler describes the hyperthyroid psychosis as a chronic condition marked by extreme excitement, dissociation of thought, confused delusions, hallucinations of hearing and sight, eventually of taste and smell, and perhaps even of physical sensations. In some cases this psychosis in the earlier stages cannot be distinguished from *dementia praecox*. It is finally differentiated, however, by the fact that emotional dullness does not supervene and the stream of thought is less disconnected.

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[15] Hoskins, R. G. The Tides of Life. The Endocrine Glands in Bodily Adjustment. *New York* (Norton) 1933. Pp. 352.

The biometric constants for weight of the thyroid gland in the several classes of the present material are set forth in Table 18.

From Table 18 it is evident, just as was the case for the adrenals, that the variation in weight of the thyroid in this material is fairly

TABLE 18

Thyroid Weight for Different Psychiatric Groups

		CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White Males	*N*	53	175	197	27
Mean .....(gms.)		22.41±0.79	22.21±0.46	21.43±0.39	22.31±1.18
Median .....(gms.)		20.96±0.99	20.17±0.57	20.65±0.49	19.64±1.48
S. D. .....(gms.)		8.55±0.56	8.99±0.32	8.05±0.27	9.08±0.83
C. V. .....(%)		38.16±2.84	40.46±1.68	37.57±1.45	40.67±4.31
Range .....(gms.)		8.7-45.7	6.5-55.0	7.2-52.0	9.0-38.0
White Females	*N*	23	70	77	..
Mean .....(gms.)		19.46±1.53	16.43±0.57	16.20±0.53	..
Median .....(gms.)		15.63±1.92	15.79±0.71	15.34±0.67	..
S. D. .....(gms.)		10.91±1.08	7.01±0.40	6.90±0.38	..
C. V. .....(%)		56.07±7.12	42.70±2.84	42.61±2.70	..
Range .....(gms.)		5.1-47.5	4.9-38.0	5.4-40.5	..
Negro Males	*N*	32	44	137	36
Mean .....(gms.)		23.13±0.99	24.66±0.82	21.51±0.52	23.89±0.93
Median .....(gms.)		21.67±1.24	23.08±1.03	18.30±0.65	22.50±1.17
S. D. .....(gms.)		8.27±0.70	8.08±0.58	8.98±0.37	8.30±0.66
C. V. .....(%)		35.75±3.38	32.75±2.60	41.73±1.97	34.75±3.08
Range .....(gms.)		10.3-45.5	11.3-45.5	2.7-54.5	9.4-42.5
Negro Females	*N*	27	39	71	..
Mean .....(gms.)		22.50±1.16	22.12±0.92	21.20±0.74	..
Median .....(gms.)		20.50±1.45	20.42±1.15	19.29±0.93	..
S. D. .....(gms.)		8.92±0.82	8.50±0.65	9.25±0.52	..
C. V. .....(%)		39.66±4.17	38.44±3.34	43.63±2.90	..
Range .....(gms.)		7.4-37.5	11.3-44.2	7.0-50.0	..

TABLE 19

Relative Thyroid Weights

RACE AND SEX	RELATIVE THYROID WEIGHT	CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White males	a. Thyroid weight per cm. of body length.....(mgm.)	132	130	126	130
	b. Thyroid weight per kg. of absolute body weight (mgm.)	400	395	434	360
	c. Thyroid weight per kg. of relative body weight (mgm.)	6812	6751	7364	6197
White females	a. Thyroid weight per cm. of body length.....(mgm.)	124	104	103	...
	b. Thyroid weight per kg. of absolute body weight (mgm.)	448	385	406	...
	c. Thyroid weight per kg. of relative body weight (mgm.)	7025	6063	6403	...
Negro males	a. Thyroid weight per cm. of body length.....(mgm.)	136	145	128	140
	b. Thyroid weight per kg. of absolute body weight (mgm.)	409	422	467	436
	c. Thyroid weight per kg. of relative body weight (mgm.)	6967	7211	7850	7442
Negro females	a. Thyroid weight per cm. of body length.....(mgm.)	141	141	133	...
	b. Thyroid weight per kg. of absolute body weight (mgm.)	422	466	496	...
	c. Thyroid weight per kg. of relative body weight (mgm.)	6757	7300	7910	...

symmetrical about the mean. In no case is there a significant difference between mean and median, having regard to probable errors. The thyroid varies widely in weight, a point noted by Roessle and Roulet. In the present material the smallest thyroid is recorded as weighing only 2.7 gm. and the largest 55.0 gm. The coefficients of variation for the several groups range from 32.75 per cent (Negro male paranoids) to 56.07 per cent (white female cycloids).

The mean absolute weights of Table 18 are reduced to relative weights in Table 19, on the same plan as used for the adrenals and fully described above.

It is difficult to the point of practical impossibility to make any really significant statistical comparisons of human thyroid weights from existing data for the reason that the weight of this organ varies so much with environmental circumstances, particularly climatic and geographic. In nongoiterous regions the gland tends to be small, while it is large in regions where goiter is prevalent, even in individuals without specific or precise clinical or pathological evidence of the disease itself.

Taking into account the fact that the population of St. Elizabeth's Hospital, from which the present data come, is drawn in major part from individuals born and raised in various places over the whole extent of the United States (since men in the military services are so drawn) it would seem insofar to represent roughly average regional conditions. The District of Columbia, from which the balance of the St. Elizabeth's Hospital population comes, may on the other hand be looked upon as a relatively nongoiterous region because of its nearness to the sea. On the whole the most fairly comparable series of thyroid weights from non-mentally diseased persons with which to compare the present figures seems to us to be Roessle's and Roulet's Jena and Basel data (*loc. cit.*, Table 29, pp. 71-72) which they regard as representing about median conditions so far as concerns environmental influence on thyroid weight. But we confess to the feeling that the comparison does not mean much, in any critical sense.

Table 20 gives the Roessle and Roulet means, absolute and relative to total body weight.

It is evident that the mean thyroid weights, both absolute and per kg. of total body weight, fall on a definitely lower level in the present material than in the Roessle-Roulet series. The differences are undoubtedly statistically significant between the two series, taken as wholes, wherever they are fairly comparable (i.e., for whites). But

TABLE 20

Mean Thyroid Weights (Roessle and Roulet), Absolute (in Gms.) and Relative (Mgm. per Kg. of Body Weight)

AGE (YRS.)	MALES		FEMALES	
	Absolute (gm.)	Relative (mgm.)	Absolute (gm.)	Relative (mgm.)
21-30	27.77±0.61	566	28.94±1.11	650
31-40	31.82±0.85	555	32.28±1.20	696
41-50	31.40±1.06	602	29.80±1.27	625
51-60	30.00±1.71	640	28.78±1.54	608
61-70	30.45±2.97	516	31.14±1.46	641
71-90	28.96±2.83	572	31.06±1.91	880
Unweighted means	30.07	575	30.33	683

whether the smaller mean thyroid weights of the present material are the resultant of the fact that we are dealing with a mentally diseased population in contrast to one not so diseased, or whether the difference merely reflects the effect of a more nearly "non-goiterous" environment, it is impossible to say with certainty.

Do the four psychiatric groups differ from one another significantly and in any orderly and regular way, in the mean mass of thyroid tissue per person? Evidently *not*, so far as concerns absolute weights, for an inspection of Table 18 shows that no psychiatric group mean in that table differs from any other (for the same race and sex) by as much as three times the probable error of the difference, save only in the case of the difference between the Negro male paranoids and schizoids where the difference is 3.15±.97. There is no evidence of any orderly or regular differentiation of the psychiatric groups in respect of absolute thyroid weight. Just possibly the schizoids may be characterized by a slightly smaller average thyroid than the other psychiatric groups, but it will take more data than we have to prove it.

The same general conclusion appears to be true for relative thyroid weights, whether referred to body length or to body weight, absolute or relative. There is no regular or striking difference in the figures of Table 19 for the different psychiatric groups.

If thyroid hormonal disturbances play a significant rôle in the etiology of particular types of mental alienation, as the clinicians suggest, our present data are sufficient to show, we think, that these disturbances are not reflected in the weight of the gland in a statistically evident manner.

Do the white and Negro groups in the present material exhibit any regular and significant difference, one from the other, in mean thyroid weight, absolute or relative? The answer is plain. *The Negroes have generally heavier thyroids than the whites,* both absolutely and relative to body length and body weight, whether absolute or relative. In the seven comparable series of Table 18, the Negro mean is larger than the white mean in every series, sex for sex. The differences are certainly significant in two cases out of the seven, and probably so in one or two others. The Negro medians are higher than those for the whites in six out of the seven cases. Taking unweighted averages of the means of Table 18 we find the Negro average, disregarding sex, to be 22.72 gm. against a white average of 20.02 gm. The latter figure is about 88 per cent of the former.

As between the *sexes,* the absolute mean weight of the thyroid is smaller in the females than in the males in all psychiatric groups and in both races, though in the Negroes generally and in the white cycloids the differences are not significant in comparison with their probable errors. The data of Roessle and Roulet (cf. Table 20) exhibit no definite difference between the sexes in absolute thyroid weight on the average. Turning to relative thyroid weight it is apparent from Table 19 that in the whites, the females of the present material have slightly smaller mean thyroid weights per cm. of body length than the males, and (with the exception of the cycloids) smaller mean thyroid weights relative to both absolute and relative body weight. In the Negroes these relations tend to be reversed, thus coming into agreement in principle with the findings of Roessle and Roulet on the point, their data showing rather consistently a higher thyroid weight relative to body weight in the female than in the male.

Fig. 4 summarizes graphically the results regarding mean thyroid weight relative to body weight—mass structural dosage of thyroid in proportion to weight of body.

This diagram emphasizes the conclusions stated above: The lack of significant differences between the psychiatric groups; the heavier thyroid equipment of the Negroes; and the lower thyroid weight among these mentally diseased patients as compared with "normals."

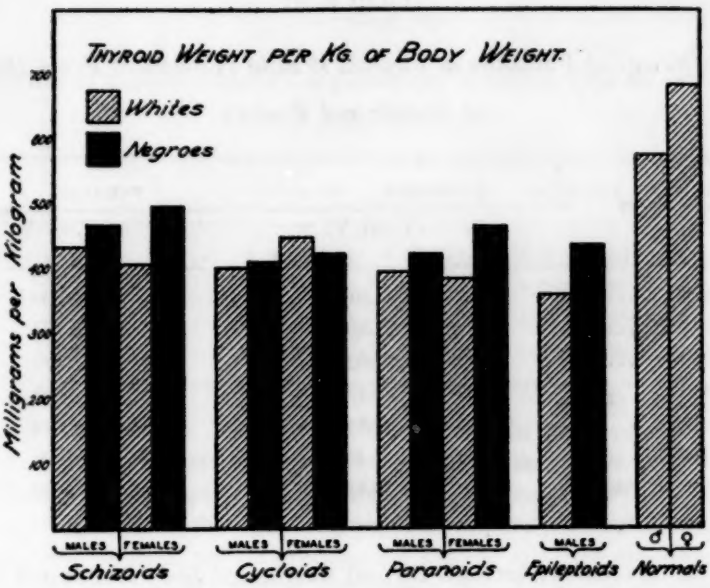

Fig. 4. Relative Thyroid Weight (Mean) in Proportion to Body Weight

Regarding the *comparative variability* in weight of the thyroid among the four psychiatric groups we reach essentially the same conclusion as in the case of the adrenals, namely that, on the whole, there are no significant differences in relative variability in respect of thyroid weight associated with different psychoses. The unweighted mean coefficients of variation from Table 18 are as follows: Cycloids 42.91; paranoids 38.59; schizoids 41.39; and epileptoids (males only) 37.71. These are generally higher variabilities than those shown by the adrenals. The thyroid appears in the present material generally to vary relatively more in weight in the whites than in the Negroes, and in females than in males. We have computed coefficients of variation from the data of Roessle and Roulet (*loc. cit.*) and present them in Table 21.

Again, just as was the case for the adrenals, the relative variabilities exhibited by the data of Roessle and Roulet are definitely lower than those shown by the present material. But in their material, as in ours, the females are relatively more variable than the males in thyroid weight.

TABLE 21

Coefficient of Variation in Thyroid Weight (Computed From Data of Roessle and Roulet)

AGE GROUP	MALES		FEMALES	
	N	C. of V.	N	C. of V.
21-30	207	31.91	79	34.00
31-40	134	31.19	73	31.85
41-50	72	28.63	59	32.79
51-60	28	30.17	53	38.93
61-70	12	33.83	52	33.74
71-90	9	29.39	33	35.24
Unweighted means	462	30.85	349	34.43

The *correlations* between thyroid weight and body length and body weight are given in Tables 22 and 23.

Of the 14 coefficients in Table 22 only one (white male paranoid) has a value as much as three times its probable error; four of the 14 are negative in sign. Altogether the only possible conclusion would appear to be that, so far as this material indicates, there is no sensible degree of correlation between the weight of the thyroid and body length.

TABLE 22

Values of the Correlation coefficient (r) Between Thyroid Weight and Body Length

	CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White males	+.157±.093	+.232±.051	+.033±.048	+.219±.130
White females	+.267±.141	−.082±.057	+.186±.077	.....
Negro males	+.213±.119	−.033±.102	+.092±.058	+.167±.112
Negro females	+.238±.130	−.054±.108	−.039±.080	.....

TABLE 23

Values of the Correlation Coefficient (r) Between Thyroid Weight and Body Weight

	CYCLOIDS	PARANOIDS	SCHIZOIDS	EPILEPTOIDS
White males	+.330±.094	+.284±.051	+.233±.049	+.413±.132
White females	+.718±.141	+.077±.081	+.287±.077	.....
Negro males	+.559±.123	+.323±.108	+.281±.058	+.243±.112
Negro females	+.464±.132	+.144±.109	+.400±.079	.....

It is evident from Table 23 that thyroid weight quite definitely tends to be more highly correlated with body weight than with body length, so far as may be judged from this material. Eleven of the 14 coefficients are 3 or more times their probable errors. All are positive in sign—the heavier the patients, on the average, the heavier are their thyroids. On the whole the cycloids exhibit the highest correlations of the thyroids with both body length and body weight, the paranoids and schizoids standing roughly together at a lower level in respect of degree of these correlations, but it must be remembered that in the present samples most of these differences are not statistically significant.

Summing the case up relative to thyroid weight, it appears that the present material shows no very definite or marked differentiation of the psychiatric groups in respect of this character. If aberrations of thyroid structure and function are significant factors in the etiology of different types of psychoses the fact is not reflected in any definite and orderly manner in the weight of the organ, so far as the present data indicate.

To be concluded

FERTILITY AND LONGEVITY IN MARRIED WOMEN DYING AFTER THE END OF THE REPRODUCTIVE PERIOD*

BY BETTIE C. FREEMAN

I. INTRODUCTION

IN MANY studies of the factors influencing populations, consideration must be given to the association between child bearing and the duration of life in women. Because of the limited age span during which propagation is possible, there are two different problems to be considered in studying this association. There is the question of the association between the duration of life during the reproductive period and the number of offspring borne, and there is also the question of association between the duration of life after the end of the reproductive period and the number of offspring borne. The purpose of this communication is to answer if possible the latter question: Is there a significant relationship between the duration of life in women who have survived the reproductive period and the number of offspring born to them during that period?

This question has been the subject of much discussion and of some investigation. It has been argued that the fact that a woman has survived the bearing of many children may be taken as evidence of a superior "vitality," and that she may properly be expected to enjoy a long life. It has been argued with equal conviction, on the other hand, that the bearing of many children is necessarily a tax on "vitality," and that a woman who has undergone this experience many times cannot be expected to survive as long as one who has borne fewer children or none at all. There are many other points of view which may be taken, and such *a priori* argument may lead to the conclusion of a positive, negative or of no assocation.

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Hufeland

Typical of this method of approach is the statement made as early as 1797 by Christopher W. Hufeland (1), in *The Art of Prolonging Human Life*: "A certain abundance in the power of generation is favorable to longevity." (2) The subject of old age was treated, as Hufeland says in the preface, "not only morally but medically." His conclusion is based only on reading and general observation.

Humphry

Quantitatively, the first treatment of the question appears to have been made in 1889 by George M. Humphry (3), in his book *Old Age*. From questionnaires sent to physicians of the British Medical Association asking for information on persons who had attained or passed the age of 80 years, he abstracted the histories of 539 women. Apparently from an analysis of the mean number of children born to these women, the conclusion is reached that "fertility which imports soundness and activity of the generative organs is indicated to have been an associate of longevity." (4) The evidence supporting this statement is slight and inconclusive.

Beeton, Yule and Pearson

The problem was seriously attacked in 1900 by Beeton, Yule and Pearson (5) in a paper *On the Correlation between Duration of Life and the Number of Offspring*. In this paper the correlation between the age at death and number of offspring was analyzed for both married men and women dying at any age. It is here necessary, however, to review only that part of the analysis which deals with the association between fertility and longevity in married women dying after the end of the reproductive period. Two groups of data were considered; data for American mothers taken primarily from *The Genealogical Record of the Whitney Family of Connecticut*, and data for English mothers taken from English Quaker Records. Age at death and number of offspring borne were the only two factors considered. Taking fifty years as the limit of the child bearing period, the regression lines of number of offspring on age at death were determined for each of the two groups of women who had survived this age. In both cases, these theoretic regression lines relating mean number of offspring and age at death showed, according to the authors, "a sensible deviation from the perpendicular." For the American Mothers, the observed mean number of offspring followed the regression line from the age of fifty years to the end of life. For the English Mothers, the observed mean number of children tended to fall below the regression line after age seventy-five. The conclusion drawn from this analysis was that "fertility is correlated with longevity even after the fecund period is passed." (6)

In the data which were analyzed there was an apparent low positive correlation between longevity and fertility in married women dying at the age of fifty years or more. When the constitution of the samples used in the study is considered, however, several questions arise which make the validity of this correlation none too certain.

In using any data for a study of this kind, it is essential that no bias element be introduced unconsciously in selecting the individuals for study. The use of genealogical records as a source of data is particularly difficult from this point of view. In a joint paper, *The Elder Peirce's,* Wilson and Doering (7) have commented upon and summarized many of the limitations inherent in data obtained from such records. The general danger involved in considering a mean age at death as an index of the longevity of a group of individuals is illustrative of one type of the bias selection which must be avoided in the study of any data, and which is of special importance in the study of data obtained from genealogical material. If a mean age at death is to be significant in the sense that it may be interpreted as a measure of the average life span of a group of individuals born at the same time, it must be based on the age at death of each member of the original group. It is essential that sufficient time be allowed for all the members of the group to have died before this average can be determined. If, for any reason, sufficient time be allowed for only a part of the group to die, the mean age at death of these individuals cannot be considered as applying to the entire group. This point seems obvious. However, it is one that is often overlooked and it is typical of the kind of error which unconscious bias selection may introduce.

In collecting the sample from the Whitney Genealogy, Beeton, Yule and Pearson used apparently all married women who had died before the genealogy was published. The material recorded in this genealogy, like most of its kind, is far more extensive for the later than for the earlier years. Furthermore, the limitation of the study to those already dead automatically excludes the large group of persons who were born in the later years of the period covered, and were still alive when the book was published. The mean ages at death, under these circumstances, are much lower than would be found if the periods selected had been limited to a time early enough for all members of the group to have died before the genealogy was compiled. The authors note the fact that for the American women the average age at death was below that found for the English group. It appears highly significant that in the American figures taken as a whole more deaths occurred between thirty-five and forty years of age than between seventy and seventy-five years. It would seem that the authors' use of the mean age at death as an index of longevity is subject to criticism on the grounds discussed in the previous paragraph.

It is well known that the mean number of children per family has tended to diminish over a long period of years. If, therefore, in the case of American Mothers studied by these authors, the sample contains Mothers taken from the later part of the genealogy, and if the mean age at death is lower than the actual by reason of the exclusion of Mothers still living at the time of publication of the genealogy, these factors alone would produce an apparent positive correlation between fertility and longevity.

Besides this effect which may reflect only the selection of material, it would seem to be necessary to take into account the possible effect of age at marriage and of duration of marriage, since both are associated directly with the number of offspring. Secular or other variations in these factors may well be the cause of an apparent association between the age at death and the number of offspring. These questions are not mentioned by the authors of the paper under discussion.

Powys

In 1905, A. O. Powys (8) published a paper *On Fertility, Duration of Life and Reproductive Selection.* The data were taken from the Vital Statistics of New South Wales for the years 1898-1902. Only that part of the study dealing with the association between longevity and fertility in married women dying after the end of the reproductive period need here be discussed.

The author first correlated the average number of children borne with the age at death in five-year groups for women dying from forty-five to seventy years of age and from seventy years and over. Then the average duration of life was correlated with the number of children borne for two groups of women, those with 0-8 children and those with 9 or more. Finally, using "deferred expectation of life" as a measure of longevity, "deferred expectation of life" was correlated with the number of offspring for women with 0-6 and 6-17 children. From the results of these various analyses, the author concluded that "the number of offspring born to a woman is highly correlated with the duration of life beyond the reproductive period," (9) and that increased longevity is associated with increased fertility up to about age seventy, after which increased longevity is associated with diminished fertility.

This study is unsatisfactory from many points of view. In the first place, as in the paper by Beeton, Yule and Pearson to which reference has already been made, age at death and number of offspring borne are the only two factors considered. No account is taken of the possible influence of age at marriage or of duration of marriage on the data. In the second place, the "correlation coefficients" were determined from mean values, and erroneously interpreted by the author to be measures of association. And finally, as can be seen from the above summary, the analyses were made on the data when they were subdivided into many varied groups arbitrarily chosen both in respect of age at death and number of offspring. The reader of this paper is cautioned against the many unit or scale changes in the various analyses which are not adequately indicated, and particularly cautioned against the designation of the statistical constants. Many of these, although identically titled, are in no sense comparable.

Bell

In 1918, Alexander Graham Bell (10) published a paper, *The Duration of Life and Conditions Associated with Longevity, A Study of the Hyde Genealogy.* Included in this study is a section on "The Duration of Life of Fathers and Mothers Compared with the Number of Children Born to Them." The data suffer from all the limitations which have been noted in connection with the paper of Beeton, Yule and Pearson. Five hundred and forty-one fertile marriages were studied. The average number of children born per fertile marriage for women dying "40 and under 60" years of age, "60 and under 80," and "80 years and over" was found to be 6.2, 6.6, and 7.2 children per marriage respectively. No other analysis was made. Bell states: "There was thus a direct correlation between the duration of life of the parents and the number of offspring born to them. The longer lived parents were the most fertile." (11) This seems a broad conclusion on such evidence.

The three most recent quantitative works which have been cited agree that there is some association between fertility and longevity even in those married women who have survived the child bearing period. The conclusions as to the type or extent of this association are not in accord, and the limitations to each study which have been mentioned, detract from the value of the final conclusions. As a result of this state of uncertainty, in 1931 Notestein (12) wrote: "It is also possible that there is some association between fertility and length of life after the end of the child bearing period, but such an association has never been demonstrated." (13)

II. THE PROBLEM

It is the object of this study to determine whether or not there exists any significant relationship between fertility and longevity in married women who have survived the reproductive period. Fertility is taken to mean the number of children born alive to the women under consideration, and longevity to denote the duration of life after the end of the child bearing period.

If it were possible to obtain a sufficiently large, truly random sample of married women dying after the end of the reproductive period, it would be a comparatively simple matter to determine the relationship between these two variables. From a practical standpoint, it is impossible to obtain such a sample. It is apparent that the question cannot be answered by any simple comparison between the number of children born and the duration of life for a group of women for whom only these facts are known. It is essential to a successful solution of the problem that the group of women selected for study be as homogeneous as possible for all variables other than the two whose relationship is to be determined.

There are many factors which are or may be associated with longevity and fertility, and which must be taken into account in selecting the basic data. These factors may in general be divided into two classes, the environmental and the physiological. Included in the first class are such factors as race, religion, distribution in time and space, economic status, number of times married, age at marriage, age of the husband at marriage, and duration of marriage. In the second are included all of the many factors associated with the physiological activity of individuals. Variations in the first group are to some extent controllable by the selection of the sample to be studied. With the present state of our knowledge variations in the second group are not entirely recognized or capable of definition, and little can be done with them in any study.

The collection of an adequate sample of women, in which some if not all of the environmental factors are known, presents great difficulty. There are three main sources from which the data might be sought,—official statistics, a canvass or questionnaire, and documentary evidence. Official statistics of death as registered are not sufficiently detailed to furnish satisfactory information. The age at death is recorded on the standard certificate of death but there are no data for the age at marriage or for the total number of offspring. To obtain detailed and accurate information regarding a sufficient number of married women, dying over a sufficiently long period of time, by the method of canvass or questionnaire, would be exceedingly difficult or impossible. Genealogical records are left as the alternative source of information, and these have been chosen for the present study.

Genealogical records are not ideal for the purpose but they seem to offer the best available approach to the problem. Many objections to the use of such material may be avoided by the selection for study only of those works which seem to be sufficiently complete and accurate. The most important criteria are: the inclusion of persons dying in infancy or at very young ages, the concordance of the significant dates as given, and especially the amount of attention devoted to the female members of the family. There is one limitation which cannot be avoided. Due to the fact that any genealogy is published primarily as a record of the descendants of an individual or group of individuals, persons who had no offspring or those whose offspring died in infancy are usually somewhat slighted as of no special interest in tracing the line of descent. Furthermore, the records for these persons appear more difficult to obtain. The information given for this class of individuals is therefore often incomplete and sometimes entirely lacking. The result is that any sample drawn from such a source will very probably be overweighted with individuals representing larger families. The effect of this factor on the material used in this study is later discussed.

III. SOURCE OF DATA AND SELECTION OF SAMPLE

From the large number of published genealogies, eleven were selected as being suitable for the present purpose. They deal exclusively with families living in the United States, and for the most part with those living in the northeastern part of the country. The genealogies used are listed below.

The Coles Family of Virginia. William B. Coles. Privately printed. *New York*, 1931.
Scholl, Sholl, Shull Genealogy. John W. Scholl. Grafton Press. *New York*, 1930.
History of the Descendants of William Ward of Sudbury, Mass. Charles Martyn. Privately printed. *New York*, 1925.
Genealogical Record of the Schwenkfelder Families. Samuel K. Brecht. Rand McNally and Co. *New York*, 1923.
The Geer Genealogy. Walter Geer. Brentanos. *New York*, 1923.
History of the Town of Durham, New Hampshire, 2 vol. E. S. Stackpole, L. Thompson. Rumford Press. *Concord*, 1913.
History and Genealogy of the Jewetts of America, 2 vol. Frederic C. Jewett. Privately printed. *Rowley*, 1908.
Genealogy of the Smedley Family of Chester, Pa. Gilbert Cope. Wickersham Printing Company, *Lancaster*, 1901.
Records of William Spooner of Plymouth, Mass. Thomas Spooner. Press of F. W. Freeman, *Cincinnati*, 1883.
The Whitney Family of Connecticut, 3 vol. S. Whitney Phoenix. Privately printed. *New York*, 1878.
The Hyde Genealogy, 2 vol. R. H. Walworth. Press of J. Munsell. *Albany*, 1864.

In collecting from these sources a group of women for study, attention was paid only to married women who were alive at the age of forty-five years, assuming this age normally to mark the end of the reproductive period. This first condition of selection removed the influence of the hazard of child bearing, as such, and avoided the loading of the sample with women for whom death in the early years of marriage had limited the number of offspring.

To insure that the apparent duration of life of the group selected was not influenced by the exclusion of any very considerable number of women still alive at the time of compilation of each genealogy, only women born eighty-five years or more before the date of compilation were included. In a very few instances, women of eighty-five years or more, still alive at the time of compilation, were assumed to have died at the age at which they were last known to be alive. This was done to prevent the entire exclusion of the large group born about the same time. The time period covered by the main body of the material is so remote that the inclusion of a few women, assumed to have died at the last age known to be alive, which varied from eighty-five to ninety-five years, can have no appreciable effect in subsequent analyses.

From the eleven genealogies were abstracted the histories of all married women, not excluded by the above primary restrictions, for whom the age at death and one or more of the following items were given: age at marriage, duration of marriage, or total number of off-

spring borne. The age at death was determined by taking the difference in years between the year of birth and the year of death. The age at marriage and the duration of marriage were similarly determined. This procedure yielded a heterogeneous sample of approximately 8,000 women.

Some selection in environmental factors was made by the original choice of the source of data. The eleven genealogies all deal with families of white stock, living for the most part in northeastern United States. Genealogical records give scant information on religion or the economic status of the individuals recorded. While it is impossible to consider these two variables separately, in these data, there seems no reason to believe that they affect the integrity of the sample.

By further selecting, from the original group of women, only those for whom certain specific facts are known, it is possible to eliminate variation in some important environmental factors and to arrive, finally, at a group for which definite information regarding other important factors is available. It was decided, therefore, to include in the final group only women who were married but once and that before the age of forty-five years. In this way the many variations introduced by multiple marriages are removed and only women potentially exposed to the risk of bearing children are studied. In the second place, it was decided to include in this final group only those whose husbands were known to be alive when the women reached the age of forty-five years. This restriction removes, for any group of women married at the same age, the effect of variations in the duration of marriage during the reproductive period on the number of offspring borne. The age at marriage of the husband is not considered in this study.

In an exhaustive investigation of the *Fertility of Marriage*, T. H. C. Stevenson (14) analyzed the effect of this factor on the number of children born to a marriage and concluded that "the husband's age at marriage may be disregarded as a matter of doubtful significance and minor importance." (15)

From the original sample, therefore, a group was selected for final study which included only those women who were married but once; who married during the reproductive period; whose husbands were known to be alive at the end of this period; and for whom the three factors, age at death, age at marriage, and total number of offspring borne, are known. This group as a whole is referred to throughout the study as the Completed Marriage Group. The histories of these women,

a total of 2,614, were coded and transferred to punch cards. The punch cards were then sorted and the results tabulated.

The details, pertinent to the present study, which were entered on the punch cards were as follows:

1. The Genealogy number
2. Individual number
3. Location—broad geographical area in which the individual resided after marriage
4. Date—quarter century of birth of the individual
5. Age at death
6. Age at marriage
7. Progeny—total number of offspring born to the individual
8. Duration of marriage—total years of married life lived by the individual
9. Fertile years of married life—total number of years married life lived by the individual from the date of marriage to forty-five years of age

IV. GENERAL ASPECTS OF THE SAMPLE

Table 1 gives the distribution of the 2,614 women by genealogical source. Since the number of individuals obtained from each genealogy is small, reflecting the highly selective character of the sample, no at-

TABLE 1

Completed Marriage Group

Distribution of Women by Genealogical Source and Time-period of Birth

TIME PERIOD OF BIRTH OF WOMEN	GENEALOGICAL SOURCE											TOTAL
	Coles	Scholl	Ward	Schwenkfelder	Geer	Durham Town	Jewett	Smedley	Spooner	Whitney	Hyde	
Prior to 1750..	..	5	60	58	18	58	66	19	33	26	133	476
1750-1799	18	56	101	144	59	111	141	173	146	185*	177‡	1311
1800-1824	38	84	131	248	31	...	176	109†	...	...	...	827
Totals	56	155	292	450	108	169	383	301	179	211	310	2614

† Women born 1800-1814

* Women born 1750-1784

‡ Women born 1750-1774

TABLE 2

Completed Marriage Group

Per cent Distribution by Number of Offspring for Women Born in Each of the Three Time-periods

NUMBER OF OFFSPRING	WOMEN BORN		
	Prior to 1750	1750-1799	1800-1824
0	2.1	2.9	3.7
1	1.9	2.0	4.1
2	4.0	4.6	8.0
3	4.6	6.8	10.9
4	6.3	8.4	12.1
5	9.2	9.5	12.7
6	12.4	12.4	11.0
7	12.0	10.7	9.4
8	12.4	11.3	9.3
9	10.3	10.7	6.3
10	9.9	9.2	5.3
11	7.1	5.0	2.9
12	4.2	3.0	2.1
13	2.5	2.1	1.4
14	.4	.8	.5
15	.4	.2	.2
16	.2	.2	..
17	..	.1	..
Totals	99.9	99.9	99.9

tempt is made in subsequent analyses to separate the data from each source. Table 1 also classifies the women making up the sample into three groups according to date of birth. The total period of birth of the women covers approximately two hundred years, roughly from 1625 to 1825. The three divisions, women born prior to 1750, those born from 1750 to 1799, and finally those born from 1800 to 1824, are purely arbitrary.

The influence of time period of birth on the number of children borne per woman is shown in Table 2, in which is given the percentage of women bearing different numbers of children for each time-period. The increase in the percentage of women bearing the smaller numbers of children, five or less, in the women born in the later periods is apparent. This evidence of a secular trend in the number of children per woman is quite definite. The mean number of offspring borne for each of the three time-periods is 7.2 for the earliest, 6.8 for the middle, and 5.7 for the last.

TABLE 3

Completed Marriage Group

Per cent Distribution by Age at Marriage for Women Born in Each of the Three Time-periods

AGE AT MARRIAGE	WOMEN BORN		
	Prior to 1750	1750-1799	1800-1824
10-14	.6	.5	..
15-19	24.2	22.3	17.4
20-24	46.2	45.9	47.9
25-29	19.5	20.8	24.4
30-34	7.1	5.9	6.9
35-39	1.5	2.7	2.4
40-44	.8	1.8	1.0
Totals	99.9	99.9	100.0

Table 3 gives for the three time-periods the percentage of women, by age at marriage, in five-year groups. In this table there is no such clear-cut evidence of secular trend as was found in Table 2. The mean age at marriage for the three periods in order is 23.3, 23.7, and 24.1 years. These differences are suggestive. Quantitatively, however, they do not at first glance appear to be sufficient to account for the differences in the mean number of children per woman for the corresponding periods.

TABLE 4

Completed Marriage Group

Mean Number of Offspring by Age at Marriage for Women Born in Each of the Three Time-periods

AGE AT MARRIAGE	WOMEN BORN		
	Prior to 1750	1750-1799	1800-1824
10-14	6.0	8.1	..
15-19	8.7	8.2	7.4
20-24	7.5	7.3	6.2
25-29	6.2	5.8	4.6
30-34	4.9	4.4	3.3
35-39	2.4	2.5	2.0
40-44	.2	.5	.5
Totals	7.2	6.8	5.7

Table 4 brings out two important relationships in these factors. In it, the mean number of children borne for each age at marriage is given for the three time-periods. There is in all three periods an orderly decrease in the mean number of children born with increasing age at marriage. For a specific age at marriage, moreover, there is in general a decrease in the mean number of children borne with the passage from

the earlier to the later time-periods of birth of the women. Groups of women married at the same age are not equally fertile over this two hundred year time-period. This is true in spite of the fact that, by reason of the restrictions imposed in the selection of the final group of women for study, the duration of marriage throughout the reproductive period is approximately constant for women married at a specific age.

It should be noted at this point that the values as given for percentage distribution of numbers of children and for the mean numbers of children borne per woman, are probably different from the values which would be obtained from a similar but truly random sample from the general population. Genealogical material is, as has been said, probably overweighted with the larger families. Inspection of the material during both compilation and tabulation, however, gave no indication that this factor was associated with any of the other factors under consideration. While the calculated values for numbers of children are possibly higher than the true values, therefore, it would appear that the relative values for the group as a whole are not affected by this feature of the material. It has been impossible to compare the values calculated from the present material with other published statistics of fertility as no comparable figures on data subdivided with the same degree of precision have been found in the literature.

Table 5 gives for each of the three time-periods the percentage distribution of women by duration of life in five-year groups, after the age of forty-five years. It is seen from this table that the three distributions are not markedly different. The variations appear to be of the type associated with random sampling. The mean duration of life for the three time-periods is 29.3, 28.7, and 28.2 years respectively. It might be well to note that eighteen women have been included who were assumed to have died at the last age known to be alive, as previously explained. Since this number represents but 0.7 per cent of the total sample, and since all these women had attained the age of eighty-five years or more, it is apparent that the integrity of the sample is not appreciably affected by this factor.

In this first examination of the sample selected for study, two facts stand out clearly. The number of offspring per woman varies with the time-period in which the woman lived, and varies also with the age at marriage or, stated otherwise, with the duration of the marriage before age forty-five. When the data are analyzed for a possible correlation between fertility and longevity, the effect of these two factors on the material will have to be considered.

TABLE 5

Completed Marriage Group

Per cent Distribution by Duration of Life After Forty-five Years for Women Born in Each of the Three Time-periods

DURATION OF LIFE AFTER 45 YEARS	WOMEN BORN		
	Prior to 1750	1750-1799	1800-1824
0- 4	4.4	5.0	5.3
5- 9	6.7	4.8	5.4
10-14	7.1	7.2	6.2
15-19	7.6	8.3	7.9
20-24	9.2	9.7	11.4
25-29	10.7	12.4	13.7
30-34	14.1	16.7	15.0
35-39	19.3	17.2	17.4
40-44	10.1	11.4	13.2
45-49	6.7	5.0	3.7
50-54	2.9	2.0	.7
55-59	1.1	.2	.1
Totals	99.9	99.9	100.0

V. THE ANALYSIS

In examining these data for a possible association between the number of offspring borne and the duration of life after the child bearing period, it was decided first to analyze it both as a whole and then divided into three arbitrary time-periods, and later to analyze it when subdivided into groups specific for both age at marriage and for time-period of birth.

Tabulations were made of the distributions by number of offspring and duration of life by five-year age periods for women born in each of the three time-periods and for the total of the three. The term "duration of life" is used to mean the duration of life after the reproductive period, that is, the difference in years between the age forty-five and the age at death. The mean duration of life by specific number of offspring and conversely the mean number of offspring by duration of life, were calculated for each table. The mean duration of life was determined from the means of the five-year age groupings with two and one-half years added to the result to allow for the life lived in the period of grouping, assuming an equal distribution throughout that period. When the observed means are plotted as will be seen in Figure 1, the regressions are linear. It is obvious from the relative positions of these means that there is very little association between the two

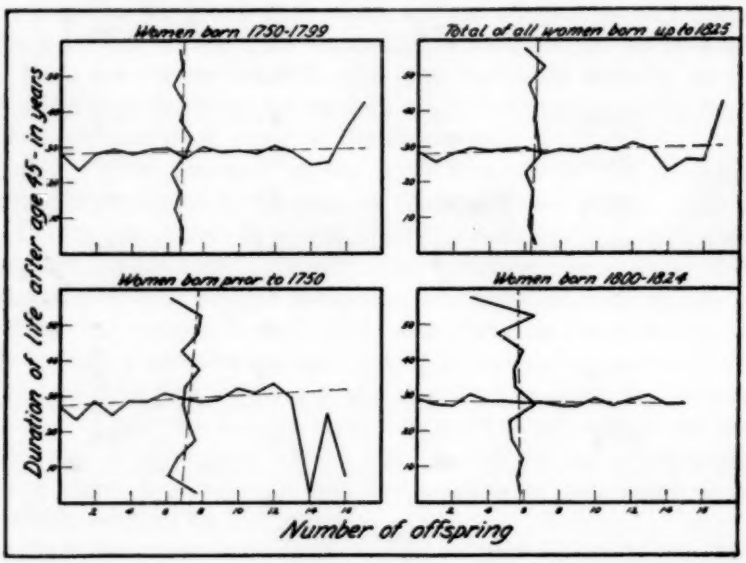
Women born 1750-1799
Total of all women born up to 1825
Women born prior to 1750
Women born 1800-1824
Duration of life after age 45 - in years
Number of offspring

FIG. 1. COMPLETED MARRIAGE GROUP. OBSERVED AND CALCULATED REGRESSION LINES OF NUMBER OF OFFSPRING AND DURATION OF LIFE AFTER AGE 45, FOR THE TOTAL OF ALL WOMEN BORN UP TO 1825, AND FOR WOMAN BORN IN EACH OF THE THREE TIME PERIODS

Legend: ———— observed means

- - - - - - - - calculated regression line

variables when the data are considered in these broad groupings. Since in the frequency tables of number of offspring and duration of life the marginal distributions are approximately normal and the range of variability in the arrays is not widely divergent, and since the regressions are linear, such tables may properly be analyzed by the normal correlation technique. This was done and the results are given in Table 6.

TABLE 6

Completed Marriage Group

General Summary of Results of Correlation Analyses of Number of Offspring and Duration of Life After Age Forty-five, for the Total of All Women Born up to 1825 and for Women Born in Each of the Three Time-periods

TIME PERIOD OF BIRTH OF WOMEN	NUMBER IN GROUP	MEAN		STD. DEV.		CORRELATION BETWEEN DURATION OF LIFE AND NUMBER OF OFFSPRING	P. E. OF $r = 0$	$\frac{r}{PE_{r=0}}$	REGRESSION COEFFICIENTS	
		Duration of Life	Number of Offspring	Duration of Life (single years)	Number of Offspring				Duration of Life on No. of Offspring	Number of Offspring on Duration of Life
Prior to 1750	476	29.31	7.21	13.32	3.10	+.0677±.0309	.0309	2.20	+.2906	+.0158
1750-1799	1311	28.71	6.78	12.55	3.16	+.0178±.0186	.0186	.96	+.0706	+.0045
1800-1824	827	28.24	5.67	12.27	3.11	—.0157±.0235	.0235	—.67	—.0620	—.0040
Totals	2614	28.67	6.51	12.61	3.19	+.0297±.0134	.0135	2.22	+.1171	+.0075

The theoretical regression lines are presented graphically, with the observed means already referred to, in Figure 1.

The four correlations are all of a very low order. In three cases, those for the total of all women, for women born prior to 1750 and for those born from 1750 to 1799, it is positive. For women born from

1800 to 1824, it is negative. For coefficients of such low order, the possibility that they may arise by random sampling variation from a universe of no correlation must be considered. The probability that a correlation of the magnitude observed, or larger, would arise solely by random sampling from an uncorrelated universe, may be determined by calculating the value $\frac{r_{obs.}}{\text{P.E.}_{r=0}}$ and reading the corresponding area under the normal curve. Examining these quotients, Table 6, it is seen that for the total of all women, and for women born prior to 1750, the value is 2.2. Interpreting this result, the chances are about 14 in 100 that a correlation of the observed magnitude or larger would arise from an uncorrelated universe by the variation in random sampling alone. For women born from 1750 to 1799, and from 1800 to 1824, the quotient is less than 1, signifying that the chances are better than even that a correlation of the observed size would so arise from a universe of no correlation.

No conclusions can be drawn from Table 6. Even if statistically significant results had been found, which was not the case, one would hesitate to conclude that there was real association, since in the composition of the samples themselves there are factors which might be combined in such a way as to produce an apparent correlation. However, this analysis foreshadows what may be expected when the data are subdivided into more homogeneous groups. There is little indication that a sizable association will be found.

VI. AGE AT MARRIAGE CONSIDERED AS A CONTROLLED FACTOR

It would seem from the preceding analysis that a "spurious" correlation has not been created by the manner in which the data were collected. The possibility remains that an existing relationship has been obscured by the heterogeneity of the material from the standpoint of age-at-marriage. To obtain groups of women that were uniform in this respect, the data were divided, regardless of time-period of birth of the women, into four age-at-marriage classes, women married under 20 years of age, from 20 to 24 years, from 25 to 29 years, and from 30 to 44 years. In the youngest age group, a total of 562 women, only ten married before the age of 15. The total number marrying at 30 years and over is too small to permit further subdivision. Of the 266 altogether, only 62 married between 35 and 39, and only 35 between 40 and 44 years.

Tabulations were made of the distributions by duration of life in five-year periods and by number of offspring, of women married in each of the four age-groups. The mean duration of life and the mean number of offspring borne were calculated as before for each table and these means are shown graphically in Figure 2. Again the regres-

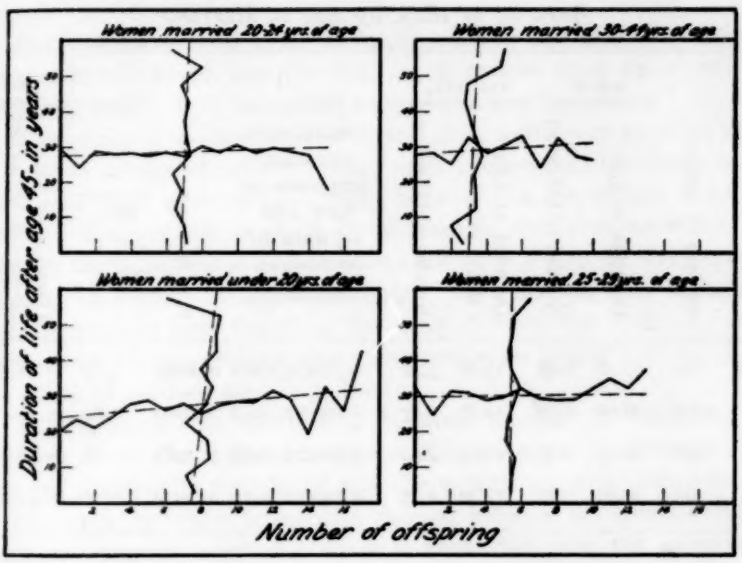
Women married 20-24 yrs. of age
Women married 30-44 yrs. of age
Women married under 20 yrs. of age
Women married 25-29 yrs. of age
Duration of life after age 45 - in years
Number of offspring

FIG. 2. COMPLETED MARRIAGE GROUP. OBSERVED AND CALCULATED REGRESSION LINES OF NUMBER OF OFFSPRING AND DURATION OF LIFE AFTER AGE 45, FOR THE TOTAL OF ALL WOMEN BORN UP TO 1825, BY AGE AT MARRIAGE

Legend: ———— observed means

- - - - - - - - calculated regression line

sions are linear and the data suitable for analysis by the correlation technique. The correlation between duration of life and the number of offspring was determined for each of the four age-at-marriage groups, and a general summary of results is given in Table 7. The theoretical regression lines can be seen in Figure 2.

The correlations for women married in each of the four age groups are positive but of a low order in every case. In general, if there were basically no correlation between these two variables, one might expect

TABLE 7

Completed Marriage Group

General Results of Correlation Analyses of Number of Offspring and Durati of Life After Age Forty-five, for the Total of All Women Born up to 1825, by Age at Marriage

AGE AT MARRIAGE	NUMBER IN GROUP	MEAN		STD. DEV.		CORRELATION BETWEEN DURATION OF LIFE AND NUMBER OF OFFSPRING	P. E. OF $r = 0$	$\frac{r}{PE_{r=0}}$	REGRESSIO COEFFICIEN	
		Duration of Life	Number of Offspring	Duration of Life (single years)	Number of Offspring				Duration of Life on No. of Offspring	Number of Offspring
Under 20	562	27.18	8.07	13.16	3.22	+.1027±.0282	±.0285	3.64	+.4198	+.0
20-24	1218	28.60	6.99	12.37	2.97	+.0365±.0193	±.0193	1.89	+.1519	+.0
25-29	568	30.13	5.46	11.99	2.52	+.0108±.0283	±.0283	.38	+.0515	+.0
30-44	266	29.02	3.22	13.40	2.25	+.0536±.0414	±.0414	1.29	+.3191	+.0

to find values of r within the range observed, but with both positive and negative values. For women married under 20 years of age, the observed correlation is +0.1027 with the P.E.$_{r=0}$ ±0.0285, and the quotient $\frac{r_{obs.}}{\text{P.E.}_{r=0}}$ is 3.6. This indicates that the chances are a little better than 1 in 100 that a correlation of the observed size or larger would arise from an uncorrelated universe by random sampling variation. This result is highly improbable. It appears from this analysis, therefore, that for women marrying under 20 years of age there is a slight positive correlation between duration of life and number of offspring borne. Looking at the regression coefficients, it is seen that on the average the addition of one child is associated with an increase in the duration of life of about 0.4 a year.

For women married from 20 to 24 years of age, not only is the observed correlation lower, but the chances, about 20 in 100, that it might have arisen from an uncorrelated universe are much greater.

Although it is impossible to conclude with any degree of confidence that in this case there is a real correlation, the evidence favors this assumption. Turning to the practical significance of a slight positive correlation, if such an assumption is made, the duration of life is increased on the average only about 0.15 of a year for each additional child, an amount which is almost negligible when its effect upon the population at large is considered.

For women married from 25 to 29 years of age, the observed correlation is still lower, and the P.E.$_{r=0}$ is greater than the correlation coefficient itself. It is impossible to predicate any association.

The group of women married in the older ages from 30 to 44 years, is small as compared with the other three classes, and the range of the age-at-marriage span is considerably broader. A correlation from this body of data, regardless of its significance as compared with P.E.$_{r=0}$, has not the same value as one computed on a group of women more uniform in respect of age-at-marriage. Nevertheless, this correlation was determined and found to be +.0536 with the P.E.$_{r=0}$ .0414. Again, one would conclude that this correlation might well be due to the effect of random sampling alone.

In summary, the correlation between number of children and duration of life for women married at different ages is positive in every case but statistically significant only for women married before the age of 20 years, in whom it appears that an increase in duration of life after 45 years of about 0.4 years is associated with the addition of each child.

VII. TIME-PERIOD OF BIRTH OF WOMEN AS WELL AS AGE-AT-MARRIAGE CONSIDERED AS CONTROLLED FACTORS

The next question which arises is, is there still evidence of this slight positive correlation when the data are made even more homogeneous by subdivision both by time-period of birth of the women and by age-at-marriage, thereby removing to some extent a possible interplay of the secular trends.

Tables were made of the distributions by duration of life and by number of offspring for women born prior to 1750, for those born from 1750 to 1799, and from 1800 to 1824, and further grouped by age-at-marriage as previously noted. The group of women married from 30 to 44 years of age was too small to permit this further subdivision. The mean duration of life and the mean number of offspring borne were

calculated for each table, and are given in Tables 8 and 9 and are shown graphically in Figure 3. Due to the small frequencies, these means are subject to considerable variation but they are still essentially linear. Each table of actual frequencies was analyzed for the correlation between duration of life and number of offspring, and the results of

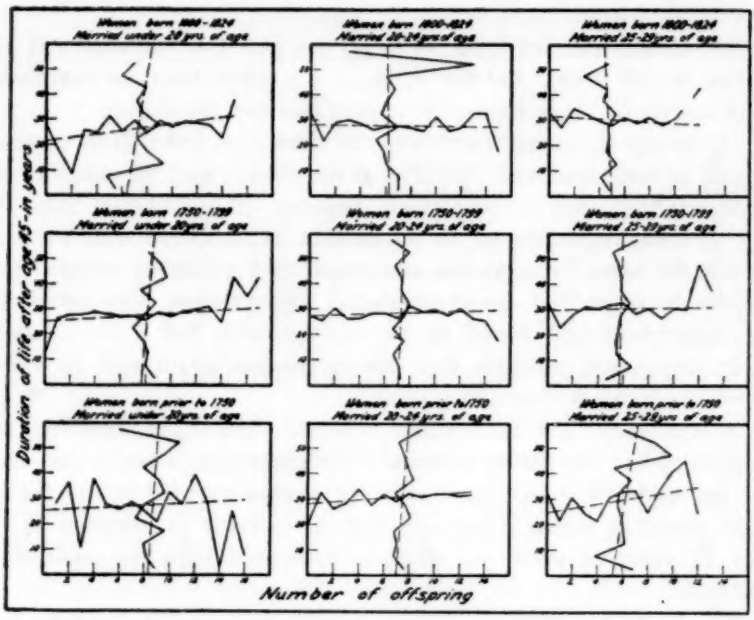

FIG. 3. COMPLETED MARRIAGE GROUP. OBSERVED AND CALCULATED REGRESSION LINES OF NUMBER OF OFFSPRING AND DURATION OF LIFE AFTER AGE 45, FOR WOMEN BORN IN EACH OF THE THREE TIME PERIODS, BY AGE AT MARRIAGE

Legend: ———— observed means

- - - - - - - - calculated regression line

these analyses are given in Table 10. This table repeats also, for convenience, the results of all similar previous analyses. The theoretical regression lines are plotted in Figure 3.

For women married under 20 years of age in each of the three time-periods, the correlation is positive in every case, and it is for the total of all women married in this group. These correlations are all greater than the corresponding values of the P.E.$_{r=0}$. While not

TABLE 8

Completed Marriage Group

Mean Duration of Life After Age Forty-five, by Number of Offspring for Women Born in Each of the Three Time-periods by Age at Marriage

NUMBER OF OFFSPRING	TIME PERIOD OF BIRTH OF WOMEN								
	Prior to 1750			1750-1799			1800-1824		
	Age at Marriage			Age at Marriage			Age at Marriage		
	Under 20	20-24	25-29	Under 20	20-24	25-29	Under 20	20-24	25-29
0	...	20.0	32.5	12.5	27.5	32.5	27.5	32.5	33.3
1	27.5	32.5	21.2	25.8	25.5	22.5	17.5	21.6	27.0
2	35.8	26.0	30.5	27.5	30.4	27.8	8.2	28.9	34.6
3	10.5	28.3	24.2	27.5	26.2	31.1	25.7	29.9	32.1
4	37.5	33.6	21.1	28.4	26.4	30.1	24.6	28.4	29.7
5	27.5	27.5	30.7	27.8	28.4	31.8	31.1	26.2	27.8
6	25.7	31.6	32.8	26.7	28.4	32.5	25.2	27.3	30.9
7	28.4	29.1	33.3	26.8	26.4	28.2	29.3	27.5	28.8
8	25.2	32.0	24.3	25.3	31.2	30.3	24.6	26.9	30.8
9	20.7	30.6	34.2	28.4	28.9	26.6	29.4	25.5	28.1
10	32.5	31.7	40.8	26.9	29.8	30.5	27.0	30.8	30.5
11	27.5	31.9	45.0	28.7	27.5	30.0	28.7	25.4	...
12	39.1	31.2	24.2	29.5	30.1	47.5	28.6	26.8	42.5
13	28.2	31.5	...	30.8	26.2	37.5	27.5	32.5	...
14	2.5	...	...	24.5	25.5	...	22.5	32.5	...
15	25.0	...	...	42.5	17.5	...	37.5	17.5	...
16	7.5	...	...	35.0	...	...	...	...	...
17	...	...	...	42.5	...	...	...	...	...
Totals	27.1	30.6	29.7	27.6	28.4	30.2	26.3	27.7	32.2

TABLE 9

Completed Marriage Group

Mean Number of Offspring Borne, by Duration of Life After Age Forty-five, for Women Born in Each of the Three Time-periods by Age at Marriage

DURATION OF LIFE	TIME PERIOD OF BIRTH OF WOMEN								
	Prior to 1750			1750-1799			1800-1824		
	Age at Marriage			Age at Marriage			Age at Marriage		
	Under 20	20-24	25-29	Under 20	20-24	25-29	Under 20	20-24	25-29
0- 4	8.8	7.6	6.8	8.7	7.2	4.6	5.5	6.9	4.8
5- 9	8.1	6.8	3.8	8.0	7.1	6.6	4.8	7.0	4.1
10-14	8.0	7.0	6.1	8.2	6.7	5.5	9.3	6.0	5.3
15-19	9.6	6.8	6.0	7.8	7.5	5.4	8.0	5.8	4.6
20-24	7.3	8.1	5.9	7.0	6.6	5.6	7.2	5.2	4.7
25-29	8.0	7.7	5.6	7.9	7.5	5.8	9.0	6.9	4.7
30-34	9.6	6.9	5.7	8.8	7.9	6.5	7.7	5.6	5.3
35-39	9.1	8.3	6.6	7.6	7.3	5.8	7.2	6.0	4.3
40-44	7.9	7.9	5.3	9.6	7.3	5.8	7.9	6.7	4.6
45-49	9.6	7.6	9.8	9.2	6.8	5.6	6.0	6.0	2.8
50-54	10.7	7.2	8.5	8.2	7.9	5.1	7.0	13.0	4.7
55-59	6.0	9.0	6.0	..	6.5	7.0	..	3.0	..
Totals	8.6	7.5	6.2	8.2	7.3	5.8	7.4	6.2	4.6

conclusive, the balance of evidence decidedly favors the assumption that a real correlation exists between the number of offspring and the duration of life, for women married in this early age group.

Considering women married from 20 to 24 years of age, there are two positive and one negative correlations. The negative correlation is small, less than one-half the value of the P.E. $_{r=0}$. The positive correlations are, on the other hand, greater than this value. These results further confirm the tentative conclusion, drawn from the analysis considering all women married in this age group regardless of time, that

TABLE 10

Completed Marriage Group

General Summary of All Analyses of Correlation of Number of Offspring and Duration of Life After Age Forty-five

TIME PERIOD OF BIRTH OF WOMEN	NUMBER IN GROUP	MEAN		STD. DEV.		CORRELATION BETWEEN DURATION OF LIFE AND NUMBER OF OFFSPRING	P. E. OF $r = 0$	$\frac{r}{PE_{r=0}}$	REGRESSION COEFFICIENTS	
		Duration of Life	Number of Offspring	Duration of Life (single years)	Number of Offspring				Duration of Life on No. of Offspring	Number of Offspring on Duration of Life
Prior to 1750	476	29.31	7.21	13.32	3.10	+.0677±.0309	±.0309	2.20	+.2906	+.0158
1750-1799	1311	28.71	6.78	12.55	3.16	+.0178±.0186	±.0186	.96	+.0706	+.0045
1800-1824	827	28.24	5.67	12.27	3.11	—.0157±.0235	±.0235	—.67	—.0620	—.0040
Total...	2614	28.67	6.51	12.61	3.19	+.0297±.0134	±.0135	2.22	+.1171	+.0075
Women married under 20 years of age										
Prior to 1750	118	27.12	8.64	14.13	3.13	+.0650±.0624	±.0621	1.04	+.2936	+.0144
1750-1799	300	27.60	8.18	12.62	3.15	+.0825±.0388	±.0389	2.12	+.3300	+.0206
1800-1824	144	26.35	7.40	13.42	3.32	+.1613±.0551	±.0562	2.87	+.6518	+.0399
Total...	562	27.18	8.07	13.16	3.22	+.1027±.0282	±.0285	3.64	+.4198	+.0251
Women married 20-24 years of age										
Prior to 1750	220	30.64	7.51	12.38	2.79	+.0837±.0454	±.0455	1.84	+.3715	+.0188
1750-1799	602	28.42	7.32	12.43	2.91	+.0338±.0275	±.0275	1.23	+.1446	+.0079
1800-1824	396	27.73	6.19	12.15	3.00	—.0150±.0340	±.0339	—.44	—.0610	—.0037
Total...	1218	28.60	6.99	12.37	2.97	+.0365±.0193	±.0193	1.89	+.1519	+.0088
Women married 25-29 years of age										
Prior to 1750	93	29.65	6.20	12.94	2.67	+.1712±.0686	±.0699	2.45	+.8306	+.0353
1750-1799	273	30.21	5.81	12.25	2.43	+.0142±.0410	±.0408	.35	+.0717	+.0028
1800-1824	202	30.25	4.65	11.14	2.34	—.0598±.0475	±.0475	—1.26	—.2847	—.0126
Total...	568	30.13	5.46	11.99	2.52	+.0108±.0283	±.0283	.38	+.0515	+.0023
Women married 30-44 years of age										
Prior to 1825	266	29.02	3.22	13.40	2.25	+.0536±.0414	±.0414	1.29	+.3191	+.0090

the association, if existing, is positive. The statistical significance of this association is, however, doubtful.

For women married from 25 to 29 years of age, there are again two positive and one negative correlations, but from the values of the quotients $\frac{r_{obs.}}{\text{P.E.}_{r=0}}$ one would hesitate to assume that there is any real association between these two variables.

It is interesting to note that the analyses by subdivisions of time at each age at marriage point to the same general conclusions as did the analyses specific for age but not for time.

The evidence points conclusively to the fact that any correlation which may exist between fertility and longevity, as here defined, is of a low order. With the size of the samples which are at hand, it is impossible to determine the exact extent of this association. The frequencies required to establish a low correlation as significant are for the most part greater than those available in the present study. Hence it is possible only to summarize the results which were observed and to weigh the whole of the evidence even though it is not finally conclusive.

It is obvious from all the analyses which have been made that the association, if any, between the two variables, duration of life and number of offspring, is slight. The possibility of a negative correlation has definitely been removed. Of 17 correlations determined by analyzing the data from many points of view, 14 were positive and 3 were negative. The negative correlations found were extremely low. Two coefficients were less than the $\text{P.E.}_{r=0}$ and the other was only slightly greater. The possibility of a positive correlation, on the other hand, was quite strongly suggested. For women married in the youngest age group, under 20 years of age, the correlation appears to be real and not due to the variation of random sampling. Its effect, however, is not great. It was found that on the average, for these women, an addition of one child was associated with an increase of about 0.4 years in the duration of life of the mother. For women married in the older age groups, not only is the statistical significance of the observed correlations doubtful, but the effect of the association, if it be assumed to be valid, appears to be one of very minor importance.

From the results of this study, it would appear that the effect of such association as may exist between the duration of life after the reproductive period in women and the number of offspring borne is of little or no significance as a factor influencing the movement of populations.

Besides the low positive correlation between fertility and longevity suggested by these data, there is some slight evidence of a positive association between the age at marriage during the reproductive period and the duration of life after the reproductive period. In Table 10 it is seen in general that as the age at marriage increases, at least up to 30 years, the mean duration of life also increases. This same relationship is apparent even when the number of offspring borne is a constant factor as may be seen in Figure 2. In general there is a greater change in the mean duration of life after age 45, with an advance in the age at marriage than with an increase in the number of offspring.

It is a well established fact that married women live on the average longer than do single women. The data which have been studied in this investigation suggest that not only the general state of being married but also the age at marriage is associated with longevity. In a later section of the paper by A. O. Powys, to which reference has already been made, there is evidence supporting this same hypothesis.

VIII. SUMMARY

The marital histories of a group of 2614 married women, dying at the age of forty-five years or more, were obtained from eleven published genealogical records of families living primarily in the northeastern part of the United States. This sample includes all those women born prior to a specified date before the year of publication of each genealogy, who were married but once and that before the age of forty-five years, whose husbands were known to be alive when the women were forty-five, and for whom the age at death, the age at marriage and the total number of offspring were known. The time-period of birth of these women covers approximately a two-hundred-year period, roughly from 1625 to 1825.

The data were analyzed by the normal correlation technique for a possible association between the number of offspring borne and the duration of life after the end of the reproductive period.

The results of several analyses, considering the data (a) as a whole, (b) divided into three arbitrary time-periods, (c) divided into four age-at-marriage groups, and (d) subdivided into groups specific for both age at marriage and time-period of birth of the women, point to the following general conclusions:

There probably is a low positive correlation between the duration of life and number of offspring borne, in married women who have

survived the reproductive period. For women married in the youngest age group, under twenty years of age, the correlation appears to be slightly higher than that for women married in the older age groups, from twenty to forty-five years of age. However, the correlations are all of such a low order that changes in the mean duration of life associated with increasing numbers of offspring are of no practical importance.

In general, this study gives no evidence that the association between the two variables is of sufficient moment to play a significant part in affecting population movements.

In the data which were analyzed, there is a suggestion of an association of slightly higher order between the age at marriage during the reproductive period and the duration of life after the end of that period.

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COEFFICIENTS OF CORRELATION BETWEEN THE NITROGENOUS CONSTITUENTS OF THE URINE AFTER INGESTION OF LOW, NORMAL AND HIGH PROTEIN DIETS

BY HOWARD H. BEARD

(From the Department of Biochemistry, Louisiana State University Medical Center, New Orleans)

WHEN the writer began his work in Biochemistry in 1925 at Western Reserve University in Cleveland he found about 700 cards containing the values (as shown in Table 1) for the excretion of the various forms of nitrogen when a similar number of medical students at different times ate a low, normal and high protein diet. These cards had been collected and preserved by my predecessor there, the late Professor J. Lucien Morris. From 1925 to 1927 many more were added to the collection, and from about 1,000 such cards, 400 were selected for a statistical study (after careful observation to remove any that obviously contained erroneous or incomplete results) of the physiological relationships existing between the excretion of these several forms of nitrogen. No study of this nature had been published at this time with normal subjects, since the earlier studies of White ('22, '25) were concerned with 50 patients who, however, were not suffering from kidney disorders, and with 50 cancer patients. The results of White are not, therefore, strictly comparable with those to be reported below.

In studying this mass of data I was struck by the fact that there was little if any relation between creatinine nitrogen excretion and body weight on all three diets (Beard, '32), and this led me to doubt somewhat the physiological significance of the well known creatinine coefficient. This lack of correlation between these two variables also pointed to the fact that body weight and endogenous metabolism were probably not the chief factors influencing the excretion of creatinine in the urine This view led to the study of Beard and Barnes ('31)

upon the feeding of proteins, amino acids and related substances upon creatine-creatinine metabolism, in which it was shown that both of these substances may also have an exogenous origin from certain precursors in the diet. In view of the surprising nature of these results final publication of both the above studies was delayed until more data could be obtained. It should be mentioned here that without statistical treatment of the data the lack of relationship between creatinine nitrogen and body weight and the relation between uric acid and creatinine would not have been apparent.

Results obtained from methods of correlation of the excretion of various urinary constituents with each other have been made by White ('22, '25), Wishart ('28), and Pucher and co-workers ('34). The importance of the statistical treatment of physiological data, the criteria necessary to be observed, and the method of calculation of the correlation coefficient between two variables, have been published by Dunn ('29).

It may be asked whether the large number of calculations necessary to obtain these coefficients (e. g., in the case of White who calculated 4,000 coefficients of various urinary constituents) reveal any more information than do the results which can be obtained by the usual chemical or physiological methods. This question can easily be answered in the affirmative.

During the past 7 years I have found time to complete the large number of calculations, begun in 1925, between the various nitrogenous constituents, the results of which are given below.

METHODS

From 1921 until 1927 the students in the course in medical biochemistry at Western Reserve University were required to make their own urine analyses after ingestion of a low, normal and high protein diet. Each analysis for a nitrogenous constituent was made in duplicate and the average value reported. Total nitrogen was determined by the macro-Kjeldahl method and the other nitrogenous constituents by the methods of Folin. All urines were preserved with 5 cc. of chloroform during the analysis.

Low Protein Diet. For three days a diet low in protein was eaten; collection and analysis of the third day specimen.

Normal Diet. The usual diet of the student for one week after the above low protein diet; collection and analysis of the seventh day specimen.

High Protein Diet. A week later a diet rich in protein was eaten; collection and analysis of the third day specimen.

RESULTS AND DISCUSSION

Chemical Data

The average values for the different urinary constituents are given in Table I, and are in general agreement with many similar studies of

TABLE I

Showing the Average Amount of Different Forms of Nitrogen Excreted When Low, Normal and High Protein Diets were Ingested (400 Specimens)

	NORMAL DIET			HIGH PROTEIN DIET			LOW PROTEIN DIET		
Volume of Urine	1364 cc.			1472 cc.			1408 cc.		
Specific Gravity	1.022			1.023			1.019		
Substance	Amount	Nitrogen Content	Per cent of Total N	Amount	Nitrogen Content	Per cent of Total N	Amount	Nitrogen Content	Per cent of Total N
	gm.	*gm.*		*gm.*	*gm.*		*gm.*	*gm.*	
Total Nitrogen	....	11.16	....	....	15.28	....	....	7.97	....
Urea	20.38	9.51	85.21	28.29	13.20	86.36	13.20	6.16	77.29
Ammonia	0.66	0.54	4.83	0.83	0.68	4.45	0.52	0.43	5.39
Uric Acid	0.57	0.19	1.70	0.63	0.21	1.37	0.54	0.18	2.26
Creatinine	1.70	0.63	5.64	1.78	0.66	4.32	1.67	0.62	7.78
Undetermined Nitrogen by Difference	...	0.29	2.62	...	0.53	3.50	...	0.58	7.28

this nature. Average data of this type naturally lead one to conclude that creatinine excretion is not related to the protein content of the diet, but statistical analysis of the data may reveal physiological relationships heretofore not known to exist.

Statistical Data

A correlation coefficient that is 4 times its probable error is usually considered statistically significant, but this does not necessarily mean that the association between the variables is sufficient to have any physiological significance. I have obtained coefficients between creatinine nitrogen and several body measurements of the magnitude of 0.13 ± 0.03 which, on physiological grounds, could hardly be considered to have any meaning. It seems fair to conclude that evidence of a physiological relationship between variables is probably not revealed unless the coefficient is not only statistically significant but also of considerable size, say 0.3 or greater to set an arbitrary standard. White stated that a coefficient of less than 0.4 did not mean very much, while one below 0.3 had no significance within itself.

Statistically speaking in a study of this nature, only two physiological variables should be present at a time, unless the method of partial correlation is used. Again several unknown factors may tend to upset these correlations. One of these might be errors in analysis by the students. However, the writer ('32) has made many creatinine estimations which checked the students' results and there is no reason to believe that they did not do fairly accurate work. To further offset this unknown variable large numbers of analyses of the students were used (800 or more for each form of nitrogen excreted on each diet), thus minimizing errors in this connection. Furthermore a statistical analysis of physiological data is usually not primarily concerned with a high degree of accuracy in physiological technique, but it is evident that the methods of analysis and the technique of the determinations must always be sufficiently accurate to measure the objects of experimentation within their usual physiological variability.

There may be some readers who will doubt the significance of statistical results applied to chemical and physiological data. In answer to this it is seen from Table 2 that a correlation coefficient of 0.91 to 0.95 ± 0.03 was obtained between the excretion of total nitrogen and urea nitrogen on all three diets. That the urea nitrogen constitutes about 85 per cent of the total nitrogen excreted daily has been known since the time of Pflüger. Hence the high degree of relationship between the total and urea nitrogen revealed by chemical analysis of the urine is also shown by the correlation coefficient.

In the past many investigators have placed much more emphasis upon obtaining correct analytical results with a few subjects than they

TABLE 2

Showing Correlation Coefficients Between Different Forms of Nitrogen in 400 Urines

VARIABLES	LOW PROTEIN DIET			NORMAL DIET			HIGH PROTEIN DIET		
	r	P.E.$_r$	$\frac{r}{\text{P.E.}_r}$	r	P.E.$_r$	$\frac{r}{\text{P.E.}_r}$	r	P.E.$_r$	$\frac{r}{\text{P.E.}_r}$
	+	±		+	±		+	±	
Total N, Urea N	0.91	0.01	91	0.95	0.03	32	0.95	0.03	32
Total N, Ammonia N	0.24	0.03	8	0.17	0.03	6	0.35	0.03	12
Total N, Uric Acid N	0.13	0.03	4	0.17	0.03	6	0.39	0.03	13
Total N, Creatinine N	0.10	0.03	3	0.10	0.03	3	0.44	0.03	15
Urea N, Ammonia N	0.24	0.04	6	0.20	0.03	7	0.31	0.03	10
Urea N, Uric Acid N	0.20	0.03	7	0.38	0.03	13	0.42	0.03	14
Urea N, Creatinine N	0.10	0.02	5	0.03	0.04	0	0.32	0.03	11
Uric Acid N, Creatinine N	0.22	0.04	6	0.31	0.03	10	0.41	0.03	14
Ammonia N, Creatinine N	0.13	0.04	3	0.16	0.03	5	0.09	0.03	3

have in studying the variations in the rate of metabolism in many different individuals. Very careful analytical results under these conditions are not necessarily representative of metabolic processes in general and prediction equations (Wishart, '28) obtained from a few cases have little if any value. In this connection Dunn ('29) stated "Variations in measurements on the same individual, even though such variation be large, is not as great as if a series of different individuals is measured." It must not be assumed that analytical accuracy is being sacrificed to secure large amounts of data, but rather that it is the physiological relationship between two variables that one should seek in studies such as are presented herewith.

Before discussing the significance of the correlation coefficients reported in this paper it will be well to state some other criteria that must be considered before the relationships revealed by the coefficients can be considered significant. From the physiological point of view there are several factors that may tend to influence the excretion of the waste products of the urine. These may be: (a) changes in the

glomerular blood pressure in the kidney; (b) changes in the acid-base equilibrium; (c) water diuresis; (d) activity of the hormones (diuretic and antidiuretic) of the posterior pituitary; (e) temperature; (f) changes in the chemical composition of the blood; (g) the amount of meat, eggs and milk in the high protein diet; (h) the calorigenic action of the proteins and amino acids.

All of the subjects were healthy male medical students. The temperature was always just below zero Centigrade. There was no reason to believe that the students drank an excessive amount of water since the daily urine volume varied from 500 to 3,000 cc. It would not seem that changes in glomerular blood pressure and the other conditions mentioned above could account for the variations found. The diet rich in protein would no doubt contain some purines and creatine, which might possibly increase the uric acid and creatinine output, but could not account for the total increase in the excretion of these substances. Beard and Barnes ('31) published data to show that the increase in creatine and creatinine metabolism after feeding amino acids and protein was probably not due to their calorigenic action. This leaves the chemical composition of the blood as the chief factor influencing the excretion of the various urinary constituents, and this would be directly influenced by the amount of protein eaten. The average data in Table 1 show that diets low, normal and high in protein were eaten by the students.

Total Nitrogen with Urea, Ammonia, Uric Acid and Creatinine Nitrogen

It is seen from Table 2 that there is a good correlation between total nitrogen and all its forms on all three diets (except in the cases of uric acid and creatinine nitrogen on the low and normal protein diets). The coefficients betwen the different variables on the diet rich in protein would seem to have a high degree of significance since it is well known that about 85 per cent of the total nitrogen is represented by urea nitrogen, thus leaving very little to be excreted, with corresponding smaller variations, in other forms.

Urea Nitrogen with Ammonia, Uric Acid and Creatinine Nitrogen

Somewhat the same relations observed above were found between the urea nitrogen and these other forms of nitrogen on all three diets.

The relation with creatinine nitrogen is also especially significant on the high protein diet. The relation with uric acid nitrogen also increases as we proceed from the low to the high protein diet. The relation with ammonia nitrogen is what one would expect from existing knowledge of protein metabolism. The coefficient between creatinine nitrogen and ammonia nitrogen is hardly significant, showing their independence in metabolism. This confirms the findings of Pucher in this connection.

White and Pucher and co-workers observed a close correlation between urea, uric acid, and creatinine. According to Pucher "It may be seen that urea, creatinine and uric acid are closely correlated and that the latter, especially under the endogenous conditions represented by the basal urines, has the highest correlation with urea, creatinine and amino acids."

Table 3 contains the coefficients obtained by White, Pucher and myself, which are in general agreement.

TABLE 3

Comparison of Coefficients of Correlation by Different Investigators

VARIABLES	WHITE HOSPITAL PATIENTS 50 SUBJECTS	PUCHER 5 NORMAL SUBJECTS 100 SAMPLES	BEARD 400 NORMAL SUBJECTS 400 SAMPLES		
			Low Protein	Normal	High Protein
Urea, Creatinine	0.71	0.36	0.10±0.02	0.03±0.04	0.32±0.03
Urea, Uric Acid	0.41	0.40	0.20±0.03	0.38±0.03	0.42±0.03
Urea, Ammonia	0.38	0.49	0.24±0.04	0.20±0.03	0.31±0.03
Uric Acid, Creatinine ..	0.27	0.54	0.22±0.04	0.31±0.03	0.41±0.03

It would seem from the above correlations that, since urea nitrogen is a product of the exogenous protein metabolism, its close relation to uric acid and creatinine nitrogen upon the diet rich in protein shows that these substances may also have an exogenous origin from the proteins and amino acids of the diet (Beard and Barnes, '31).

Bollman ('29-'30) has also published evidence to show that the level of protein metabolism is of great influence upon the creatine-creatinine transformation in the dog. It is of interest in this connection that the observations of F. G. Benedict ('07-'15), Pucher and co-workers ('34), Palmer, Means and Gamble ('14), and Beard ('32) do not support the view that the excretion of creatinine is an index of cellular or basal metabolism.

Uric Acid and Creatinine Nitrogen

Another important fact observed in 1925 was the close relationship between these two nitrogenous constituents on all three diets. This indicates that these two substances are related to each other in their respective paths of metabolism. There is also other evidence to show that they may be products of the exogenous metabolism.

For instance Abderhalden and Buadze ('30) ('31) have shown that purines and histidine can cause an increase in creatinine excretion. This effect of histidine has also been observed by Shapiro and Zwarenstein ('32), and Beard and Barnes ('31). Ackroyd and Hopkins ('16), and Rose and Cook ('25) have shown that purines are formed in part from histidine, and Chrometzka ('33) observed that the administration of uric acid or nucleosides produces an increase in the daily total creatinine output in a series of patients.

It is evident, therefore, that histidine must be considered as at least one of the mother substances of both uric acid and creatinine of the urine. These facts confirm Abderhalden's view that creatinine is bound up with uric acid metabolism.

Several other amino acids besides histidine have also been shown to increase the creatinine excretion in several physiological and pathological conditions.

These are glycine, (Beard and Barnes ('31), Tripoli and Beard ('34), Beard, Andes and Tripoli ('34), Stekol and Schmidt ('33), Mettel and Slocum ('33), Reinhold, *et al*, ('34), Schmitt ('34)); alanine (Beard and Barnes, '31); arginine (Beard and Barnes ('31), Shapiro and Zwarenstein ('32), Takahashi ('33)); glutamic acid (Beard and Barnes ('31), Tripoli and Beard ('34), Beard, Andes and Tripoli ('34)); valine, tyrosine, and cystine (Beard and Barnes, '31); *dl*-methionine (Stekol and Schmidt, '33). Takahashi ('33) also observed that injection of tyrosine, glutamic acid, serine, histidine and especially arginine into the hen's egg promoted creatinine formation.

Beard, Andes and Tripoli ('34) observed an increased creatinine excretion in the urine of 10 out of 24 patients suffering from various myopathies after treatment with glycine or glutamic acid. Thomas, Milhorat and Techner ('33) do not believe that urinary creatinine is formed by the dehydration of creatine, while Chanutin and Kinard ('32) did not find any correlation between muscle creatine and creatinine coefficient. These observations are in general agreement with the lack of relation between creatinine excretion and body weight (Beard, '32).

Thus from chemical, statistical and clinical data it is evident that uric acid and creatinine may arise from both an exogenous and endogenous metabolism as follows:

	Endogenous	*Exogenous*
Uric acid	Purines, Proteins	Amino acids
Creatinine	Purines, (Creatine?)	Amino acids, (Creatine ?)

According to the theories of the endogenous metabolism of Sherman ('20), and Osborne and Mendel ('14) this type of metabolism would be largely suppressed or abolished when the organism is receiving protein in the diet. Mitchell and Hamilton ('29) explain these theories as being due to a "retardation of the hydrolysis of tissue protein caused by the mass action of the amino acids coming from the digestive tract, or because of the complete suppression of the hydrolysis of tissue protein, initiated, in the absence of amino acids of dietary origin, by the urgent need of the body for certain nitrogenous hormones; with the influx of amino acids from the intestinal tract, exogenous precursors of these hormones become available, and the endogenous catabolism is reduced to the inevitable destruction of the hormones themselves in the course of general metabolism."

The above theories would indicate an exogenous type of metabolism when proteins or amino acids are ingested, and published evidence shows that uric acid, creatine and creatinine, may all be formed from these exogenous sources. Thus the greater the intensity of the amino acid metabolism per unit of time the more would these substances be derived from an exogenous, as opposed to an endogenous, metabolism.

SUMMARY

The correlation coefficients between various nitrogenous constituents of the urine have been calculated from data obtained from urine analysis of 400 normal male medical students after each ate a low, normal and high protein diet during the month of January each year from 1921 to 1927. These coefficients indicate the following:

(1) The metabolic relationships existing between total nitrogen and urea, ammonia, uric acid and creatinine nitrogen are very significant when a diet rich in protein is ingested. These relationships are greater than average analytical results would indicate.

(2) The relationship between the excretion of urea nitrogen and uric acid and creatinine nitrogen, when the diet rich in protein was ingested, indicates a possible exogenous origin of these two substances.

(3) The close relationship between uric acid and creatinine nitrogen (with one exception) is shown. The rôle of histidine and other amino acids as precursors of these substances is discussed.

(4) The possible endogenous and exogenous origins of uric acid and creatinine are given.

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SOME BIOLOGICAL FACTORS IN PERSONALITY AND MARRIAGE

BY JESSIE BERNARD

THE PROBLEM

THE problem raised in the present study is: What relationship if any exists between such factors as health, frequency of sex relations (as a function of recency), and the use of birth control on the one hand and such items as neuroticism and marital satisfaction on the other?

THE SUBJECTS

The subjects studied were 71 women and 64 men, representing 73 marriages. Their names were secured from the files of the St. Louis Citizens' Relief Committee, Unit A.[1] Postcards were sent to 112 families by their respective social workers, inviting them to coöperate in a study, the nature of which was not disclosed. If they were interested they were instructed to appear at the offices of the Citizens' Relief Committee at a scheduled time. Approximately 60 per cent responded. The selection was not on the basis of the nature of the study since they did not know when they came what it was to be. They were paid at the rate of approximately $0.35 per hour for their time and coöperation.[2]

The subjects here studied should not be confused with the chronic charity case. They were for the most part average middle-class men and women who had always been able to take care of themselves financially until the present depression. Most of them were C. W. A. workers at the time of the study, January 20-23, 1934. Practically all of them had had at least a grammar school education, many a high school education, and one man was a college graduate. Their intelligence quotients would probably average around 100. In short, they were the average man-on-the-street type of personality.

[1] I wish to express my appreciation to Miss Alice Taylor, an acting supervisor of Unit A when the study was made, and to the enthusiastic staff of her office for their whole-hearted and willing coöperation in securing the subjects.

[2] This project was financed by Dr. L. L. Bernard. It was undertaken in his seminar on Personality.

THE INSTRUMENTS USED

The instruments used were: for measuring personality, the Bernreuter Personality Inventory; for measuring marital adjustment, a "marriage inventory." [3] Unfortunately, although we have measures of vital capacity, blood pressure, basal metabolism, blood counts, etc., we do not have measures for what we ordinarily call health. In the present instance ratings were relied on. Each husband and wife was asked the following question: "Judging by the people you know would you say that your wife (or husband) was below average, average, or above average in health?"

The results of this inquiry are here presented with full recognition of the crudity and relative inefficiency of the instruments used. The results, furthermore, hold only for this particular sample under the particular time and place conditions specified. In very few instances are the results clear-cut and unequivocal.

HEALTH

The relationship between health and other factors was found by comparing the mean scores of those reported by their spouses to be above average in health with the mean scores of those reported by their spouses to be below average in health. Where the critical ratio between

[3] This consisted of one hundred questions calling for a "yes" or "no" reply, similar in form to the Bernreuter Personality Inventory. Examples of the questions are: "Is your husband quick-tempered?" "Is he careless about your feelings?" "Does he 'make love' to you as much as you wish?" Perfect "truth" was, of course, not expected. Each maladjustment was weighted according to the frequency with which it was admitted. That is, a maladjustment which was admitted by large numbers of people was given a small standard weight, whereas maladjustments rarely admitted were given large standard weights. No names were requested; in fact, anonymity was strongly stressed in order to encourage frankness. The situation resembled an interview situation and many people were eager to discuss their marriages in much greater detail than was called for. The replies represent probably a truthful conscious attitude. Whether or not the unconscious attitude is represented it is, of course, impossible to state. The reliability of the Marriage Inventory (Spearman-Brown formula, odd items versus even items) was .95 for the men and .97 for the women. The validity is undetermined; rank correlations between scores on the Inventory and rankings by social workers vary between .46 and .83. Between the present Inventory and another measuring instrument (see An instrument for the measurement of success in marriage, *Pub. Amer. Sociol. Soc.*, XXVII: 94-106, May, 1933), the correlation was $.77 \pm .04$.

the difference of the means and its standard error was one or less, no relationship is reported.

No relationship was found between health, as here measured, and: age, neuroticism in men, or the use of birth control. The difference between the means in neuroticism for women above average in health and below average in health was 38.4, but there is about 1 chance in 8 that this was fortuitous (critical ratio, 1.5). The healthy women were definitely less neurotic, that is to say, but the results were not unequivocal.

There was no relationship between the marital satisfaction of women and the health of their husbands. There was, however, a slight but not clear-cut relationship between the marital satisfaction of women and their own health. That is, the healthy women showed somewhat more satisfaction in marriage than the unhealthy. The difference in the averages of the two groups was 8, with about 1 chance in 5 that it was a fortuitous difference (critical ratio, 1.3).

On the other hand, there was a definite relationship between the marital satisfaction of men and both their own health and their wives' health.[4] The men who were above average in health showed more dissatisfaction with their wives than did those who were below average. The difference in the means was 10.1, with practically no chance that it was an accidental one (critical ratio, 3.3). But the men whose wives were above average in health showed more marital satisfaction than those whose wives were below average in health.[5] The difference in means was 11.0, with practically no chance that this was accidental (critical ratio, 3.6).

The relationship between health and recency of sex relations will be discussed below.

RECENCY OF SEX RELATIONS

O. L. Harvey has summarized the results of all the studies relating to the frequency of human coitus.[6] These studies secured their data

[4] The coefficient of contingency between the health of husbands and wives was .27, with a possible maximum of .82.

[5] Some of the comments made illustrate and illuminate this point concretely. For example, one woman whose marriage scored very low said, "I am sick and I think that is the trouble." One husband explained that "My main trouble with her is the change of life working on her."

[6] A note on the frequency of human coitus, *American Journal of Sociology*, XXXVIII: 64-70 (July, 1932).

by asking the subjects how frequently they had had sex relations at various periods of their married life. In the present study a slightly different approach was made. On the theory that frequency was a function of recency, 49 women were asked when they had last had sexual intercourse with their husbands. The replies were surprisingly precise, such as "last Sunday," "January 17," etc. In only a few cases were the replies vague, such as "two weeks ago" or "about a week ago." The results are as follows: Of the 49 reports on recency 2 are for one day; 8 for 2 days; 8 for 3 days; 2 for 4 days; 2 for 5 days; 2 for 6 days; 10 for 7 days; 1 for 8 days; 3 for 10 days; 2 for 13 days; 3 for 14 days; 1 for 17 days; 2 for 21 days; 1 for 31 days; and 2 for 42 days. Modal points seem to be indicated at 2, 3, and 7 days approximately. If we assume that these represent mid-points in the inter-coitus interval, these figures would indicate modal frequencies of about half a week, a week, and two weeks.

No relationship was found between recency of sexual intercourse and age of either husband or wife. This is in keeping with the findings of Dickinson and Beam, but contrary to those of Pearl.[7] No relationship was found between recency of sex relations and: neuroticism in husbands, marital dissatisfaction of husbands or of wives, number of children, or number of years married. The correlation between the number of days since the last intercourse and neuroticism in wives was $.21 \pm .14$,[8] which is low and means that there is 1 chance in 8 that the relationship is not real.

An illogical and hence perhaps accidental relationship was found between the reported health of women and recency of coitus. That is, women below average in health had had sex relations more recently than women above average in health. The difference in the mean number of days since last coitus was 4, with 3 chances in a hundred that it was accidental. Since there is no reason to suppose any relationship as here indicated, we might perhaps conclude that in this case we have struck one of the 3 chances in the hundred!

Between the reported health of husbands and recency of sex relations the relationship was clear. Men above average in health had had sex relations more recently than men below average. The difference in means was 10.8, with scarcely any possibility that it was accidental (critical ratio, 3.6).

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[7] *Ibid.*, p. 68.

[8] Standard error given in all cases.

USE OF BIRTH CONTROL

Thirty-nine women were asked if they used any means of birth control. It was an error in technique not to have asked for specific methods used in each case, since the methods used might have different emotional effects. Forty per cent of the women who had not reached menopause age reported the use of birth control. Hamilton[9] in a different type of sample found 90 per cent and Pearl[10] in a sample similar to the present one found 45.3 per cent. No relationship was found between the use of birth control and: age of either husband or wife, number of years married, neuroticism in women, or number of children.[11] If menopause age women are omitted the average age of women who use birth control and those who do not is exactly equal.

Bi-serial correlation between the number of days since the last coitus and the use of birth control was —.18; if women past the menopause age are omitted, the bi-serial correlation is —.24. If these figures mean anything they indicate that the use of birth control favors greater frequency of sex relations. The correlation, however, is low.

A slight but possibly chance relationship was found between marital dissatisfaction and the use of birth control, the bi-serial correlation for men being $.23 \pm .16$, and for women, $.35 \pm .14$. The dissatisfaction seemed to be greater with women than with men.

The husbands of women who reported the use of birth control seemed to be more neurotic than those who did not. The difference in the mean scores of the two groups was 50, with very little chance that it was accidental (critical ratio, 2.9).

NEUROTICISM[12]

The relationship between neuroticism and health, recency of coitus, and the use of birth control has been discussed in the preceding pages.

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[9] G. V. Hamilton, *A Research in Marriage*, 1929.

[10] Raymond Pearl, Contraception and fertility in 4945 married women. A second report on a study of family limitation. HUMAN BIOLOGY, Vol. 6, pp. 355-401, 1934.

[11] It is the policy of some clinics to refuse birth control information to women who have fewer than a certain number of children.

[12] As a group the men were normal with respect to neuroticism, according to the norms given by Bernreuter. The women, however, were more neurotic than average, using Bernreuter norms. Their median score was 36 points higher than the median score of the group on which the instrument was standardized.

Between neuroticism and marital dissatisfaction the relationships were as follows: Neurotic women tended to be more maladjusted in their marriages than more normal ones, the correlation between neuroticism and marital dissatisfaction being .41 ± .07. There was no such relationship for men.[13] But the correlation between neuroticism in wives and the marital dissatisfaction of their husbands was .32 ± .13. Neuroticism in husbands was not related to marital dissatisfaction of their wives. It would appear that the personality of the wives was a more determinative factor in the marital adjustment of both themselves and their husbands than the personality of the husbands.

SUMMARY

In a sample of 71 women and 64 men of the average middle-class type, no relationship was found between:

1. Health of husbands and marital satisfaction of wives
2. Health and
   a. Age of either men or women [14]
   b. Neuroticism in men
   c. The use of birth control
3. Recency of sex relations ($N = 49$) and
   a. Age of either husband or wife
   b. Neuroticism in men
   c. Marital dissatisfaction of either husband or wife
   d. Number of children
   e. Number of years married
4. The use of birth control ($N = 39$) and
   a. Age of either husband or wife
   b. Number of years married
   c. Number of children
   d. Neuroticism in women

[13] If there had been a definite relationship between marital dissatisfaction and neuroticism among the men it might have been argued with much plausibility that the correlation meant simply that people who were willing to admit neurotic traits in themselves were also willing to admit maladjustments in their marriages. The lack of relationship between these variables among men, however, discounts this hypothesis.

[14] The form of the question with respect to health may account for this. Each person may have judged the health of his spouse in terms of other individuals of the same age. The effect would be to partial out age.

5. Neuroticism in husbands and marital dissatisfaction of either husband or wife

Slight but possibly chance relationships were found between:

1. Health of women and
   a. Lack of neuroticism
   b. Marital satisfaction
2. Number of days since last coitus ($N = 49$) and
   a. Neuroticism in women
   b. Lack of use of birth control
3. The use of birth control ($N = 39$) and marital dissatisfaction of both husbands and wives
4. Neuroticism in wives and marital dissatisfaction of husbands

Definite positive relationships were found between:

1. Health of husbands and
   a. Marital dissatisfaction of husbands
   b. Recency of sex relations
2. Health of wives and marital satisfaction of husbands
3. Number of days since last sex relations and poor health of husbands ($N = 49$)
4. Use of birth control and neuroticism in men ($N = 39$)
5. Neuroticism and marital dissatisfaction in women

THE AMALGAMATION OF ETHNIC GROUPS

BY RAYMOND ROYCE WILLOUGHBY

Clark University, Worcester, Mass.

THERE can be no considered doubt of the fact of inter-group assimilation in any region where different groups are in contact; but in spite of the number of important problems dependent on this fact, there have been few thoughtful attempts to work out the technical apparatus necessary for accurate description of the phenomena. The present note represents no fundamental attack, but endeavors only, on the basis of inadequately elaborated concepts and small and selected populations, to draw the attention of more satisfactorily equipped investigators to the problem, which we believe to be of prime sociological and demographic importance.

Attention will be directed chiefly to two phases of the assimilation process: the relative amount of the "blood" of each group in the total, and its distribution. Each of these phases may be considered from the viewpoint of status at any moment (such as the present) and from that of rate. We can see no alternative to the expression of these in terms of "blood" fractions, however inexact this may be from the standpoint of exact genetics; and the obvious unit is the person-equivalent. Thus five persons each bearing one-quarter of the "blood" of Group X may be said to have, collectively, 1¼ person-equivalents of the blood of that group. The problem of relative amounts mentioned above, then, may have a solution (when the necessary data are available) in the form "Group X has a representation of n person-equivalents, Group Y of r person-equivalents, in the total population of s"; and this may be stated in percentages if desired.

The second problem, that of distribution, may likewise have a solution in the form "The n person-equivalents of Group X are distributed as d three-quarter-bloods, e half-bloods, f quadroons, g octoroons, etc."; and this may have the variant form "k per cent of the n person-equivalents of Group X are in z per cent bloods or less." Thus a high value of n relative to s will signify a heavy loading of the population with the

element X, and a high value of k (unless the critical value z be taken unduly high) will signify that this element is widely distributed or well assimilated. These are status evaluations; rate evaluations may be easily made by determining the difference in status traversed by any of these variables per unit of time; thus the element X is decreasing in the population if n is decreasing relative to s, and it is becoming assimilated if k is increasing (if z be taken at or below 50).

PROPORTION OF INDIAN BLOOD IN NEGRO-INDIAN-WHITE MIXTURE

With these tools we may approach a small but carefully studied mixed population, that published by Caroline Bond Day in her report (Harvard African Studies, vol. X, Part II) entitled *A Study of Some Negro-White Families in the United States.* It has not proved possible to secure access to the original data, so that the analysis here offered is based upon the 46 families published, and is accordingly principally methodological rather than sociological in its implications. We shall consider first the 22 families showing Indian admixture. These have, in the latest generation recorded, 7 7/16 person-equivalents of Indian blood in a total population of 155 (number of individuals recorded for the latest generations in the entire 46 families published); this is a percentage of 4.8. Any attempt to estimate the rate of change numerically would be misleading, since for the most part no account was taken, in the collecting, of collaterals in the higher generations; in view of the decline of the birth-rate shown in the report, however, as well as of facts presently to be reported on distribution, there is every reason to believe that the proportion of Indian blood is declining precipitately.

The facts regarding distribution are more satisfactory. The distribution of Indian blood is as follows (in the latest generation):

17/64	1/4	5/32	1/8	3/32	5/64	1/16	1/32	1/64	Total
2	5	10	10	5	5	25	13	13	88

30 per cent of the distribution lies below 1/16, and 70 per cent of it below 1/8; thus it must be regarded as in a very advanced stage of assimilation. Neglect of the collaterals will not have in this case the selective effect avoided above, since the individuals enumerated are presumably a random sampling of their generations in respect to distribution, though not to sibling number. The distribution of the *first* generation in which Indian blood was noted is as follows:

1/2	3/8	1/4	5/32	1/8	1/16	Total
1	1	8	1	10	1	22

Here 0 per cent of the population lies below 1/16, and only 5 per cent below 1/8. The median of the first generation divides the octoroons from those of higher blood, and may be stated as 9/64 or .14; in the last generation it lies in the 1/16 group, and may be stated as 4½/64 minus 9/640 * or .06. The distribution of the number of inter-generation spans in which this was effected being

1	2	3	Total
8	9	5	22

it follows that we may (somewhat crudely to be sure) express the rate of change in distribution as of the order of .08 for the two spans (median), 1/25 of a person-equivalent per span, or 10-15 per cent of a person-equivalent of shift in the median per century. It will probably not be difficult for the statistically sophisticated to refine this measure, but its outlines seem reasonable and simple. Examination of the raw data suggests, in fact, that at this advanced stage of the assimilation process the computation should be geometrical rather than arithmetical, inasmuch as there are in the 47 separate inter-generation spans involved only 6 cases of departure from regular halving of the blood with successive generations.

NEGRO-WHITE MIXTURE

The negro-white mixtures present a more formidable problem. Here we have numbered the generations, wherever reasonable estimates were possible, from the primary cross. Thus the F_1 generation is always, by definition, of the half blood. The F_2 generation, however, may contain more, less, or an equal amount of white blood (we have made the computations in terms of fractions of the white blood because of the complications introduced into the negro fraction by the Indian admixture); and so for succeeding generations.

The F_2 generation contains 71 13/16 person-equivalents of white blood, in a total population of 125 individuals (57 per cent); the F_3 generation, 106¼ person-equivalents in a total of 178 (60 per cent); the F_4 generation, 49 7/32 in 90 (55 per cent); F_5, 12 1/16 in 19 (63 per cent); and the single individual recorded from F_6 is 43/64 white (67 per cent). Treating the data as in the case of the Indians, we have for the last generation recorded 86 61/64 person-equivalents of white

* 7½/25 x 3/64.

blood in a total population of 155 (56 per cent); the first generation is identical with F_2 above (57 per cent). If this basis be accepted, then, there is no significant change. We prefer the treatment based on the enumeration of successive generations from the primary cross, as slightly more accurate; but the results of this are not wholly unequivocal, since the last two generations are numerically inadequate and the first three have no single trend. Probably the safest conclusion, in view of this uncertainty, is that in this population where negro-white mixture has begun, the tendency for the first few generations is for the amount of blood to gravitate slightly toward the majority group; but that not enough material has been gathered to determine whether this tendency will persist or whether there will be a subsequent regression to the minority stock.*

The distribution of white blood by generations is given in Table 1. Reference points will be stated in Table 2 in this case in terms of percentages lying *above* given fractions, since the proportions are given in terms of the blood of the majority group.

The medians for the successive generations lie in the following groups: F_2, 5/8; F_3, between 5/8 and 19/32; F_4, 9/16; F_5, 17/32; or in terms of 32nds, 20, 19½, 18, 17. Thus in terms of this somewhat unsatisfactory measure, there is a slight regression toward the minority groups; or the minority blood present is tending slightly to become more concentrated, i.e., to be contained in relatively fewer individuals. Again, however, the tendency is very slight, and the safest conclusion from all approaches seems to be that in this group, on the average, the minority blood is in a slightly greater than intermediate stage of assimilation, with a large variability as between individuals in a given gener-

* On a priori grounds we should expect the former; for on the one hand a small but constant stream of majority "blood" flows into the minority group (e. g., 3 per cent of New York State marriages recently reported were between negroes and whites, and presumably the proportion of fertile unrecognized matings is much larger); and on the other, a relatively large number of individuals pass over continually from the minority to the majority group, their biological and sociological assimilation having been virtually completed. A crude analogy would be that of two adjoining vats, one containing some 10 quarts of ink, the other some 120 quarts of milk (each, at the present juncture, already somewhat diluted with the other); into one end of the ink vat flows a slight trickle of milk, and from the other end the most diluted masses of ink are piped back into the milk vat. Upon the rate of these processes alone, it would seem, depends the date at which both vats will contain a homogeneous mixture of slightly inky milk.

TABLE 1

Distribution of White Blood by Generations in Negro-White Crosses

	7/8	13/16	25/32	3/4	11/16	43/64	21/32	41/64	5/8	19/32	9/16
F_1	..	..	..	..	..	..	..	..	..	..	..
F_2	..	..	..	44	12	..	..	..	7	..	19
F_3	10	5	..	16	19	..	..	..	38	17	2
F_4	..	7	..	1	5	..	5	8	1	13	11
F_5	..	..	2	..	1	..	2	..	..	4	..
F_6	..	..	..	..	..	1	..	..	..	..	..

	35/64	17/32	1/2	15/32	7/16	13/32	3/8	23/64	5/16	9/32	1/4	3/16	1/8
F_1	..	..	46	..	..	..	..	..	..	..	..	..	..
F_2	..	..	17	..	..	..	3	..	..	4	19	..	..
F_3	4	5	38	..	7	..	17	..	..	..	..	..	1
F_4	..	..	7	15	8	..	..	..	4	..	3	2	..
F_5	..	1	..	6	..	1	..	2	..	..	..	..	..
F_6	..	..	..	..	..	..	..	..	..	..	..	..	..

ation; and that not enough data (particularly not enough generations) are available to determine whether there is a definite trend toward either concentration or assimilation.

Our conclusions are limited chiefly by the fact that our population is by definition one of mixed blood; thus any generalization must commence with the proviso "If mixture has already begun. . . ." The unmixed Indians in the United States may still number a hundred thousand, and the unmixed negroes into the millions; the phenomena here studied take place only, so to speak, in the narrow zone of contact between the groups (though this zone is probably to be thought of, under modern conditions, as multiple and "insular," as contrasted with the single and "continental" form which it had in, say, the seventeenth century). The effect of this is to make the amount of assimilation appear smaller than it actually is; but operating in the reverse direction is the fact that the population studied also does not contain individuals whose assimilation has been, for practical purposes, completed; to what extent these factors counteract each other we have no means of estimating. Probably what we need is a series of studies, on lines similar

TABLE 2

Cumulative Percentages of White Blood in Negro-White Crosses

	Per cent above		
	¾	½	¼
F_1	..	..	..
F_2	0	66	85
F_3	8	65	99½
F_4	1	57	94
F_5	11	53	100
F_6	..	..	..

to those indicated herein, of single small populations each consisting of a majority and a minority group; from the conclusions of such a series a generalization might be drawn in the form "Assimilation is progressing, in the populations considered, at rates (defined as indicated above) of a to $a + b$ per generation."

To summarize, we have proposed measures (presupposing adequate genealogical data) for the total amount of the "blood" of a minority in a population and for its distribution, and have suggested that by the use of these measures these aspects of miscegenation could be profitably studied with respect to either status or rate; and by the application of these measures to a population already mixed, we have arrived at the tentative generalizations that (1) when mixture between Indians and negroes has once begun, the former are rapidly assimilated into the latter; (2) when mixture between negroes and whites has once begun, assimilation takes almost at once (in terms of generations) a position somewhat beyond its mathematical half-way point; but sufficient data are not available to determine whether further change proceeds forward or backward from that position.

RECENT LITERATURE

USEFUL IN THE STUDY OF HUMAN BIOLOGY

In this department will be noticed the books and reprints which are currently received at the Editorial Office. Publications intended for notice here should be addressed to Dr. Raymond Pearl, Department of Biology, School of Hygiene and Public Health, 1901 East Madison Street, Baltimore, Maryland, U. S. A.

I. EVOLUTION AND GENETICS

1. *Evolution—General Principles*

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